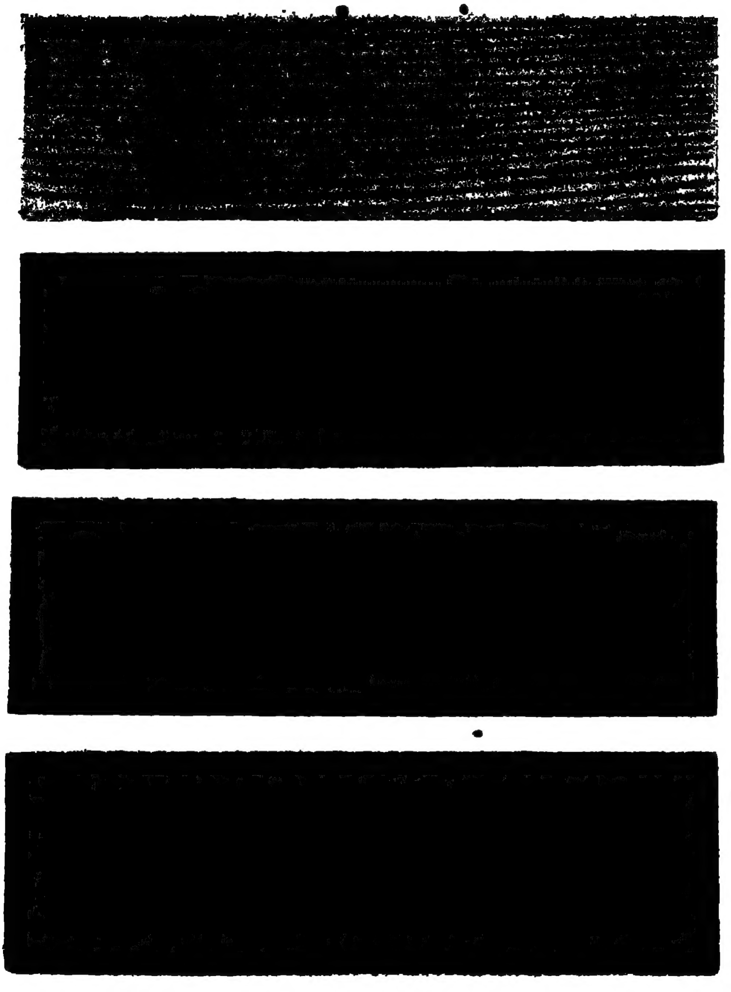
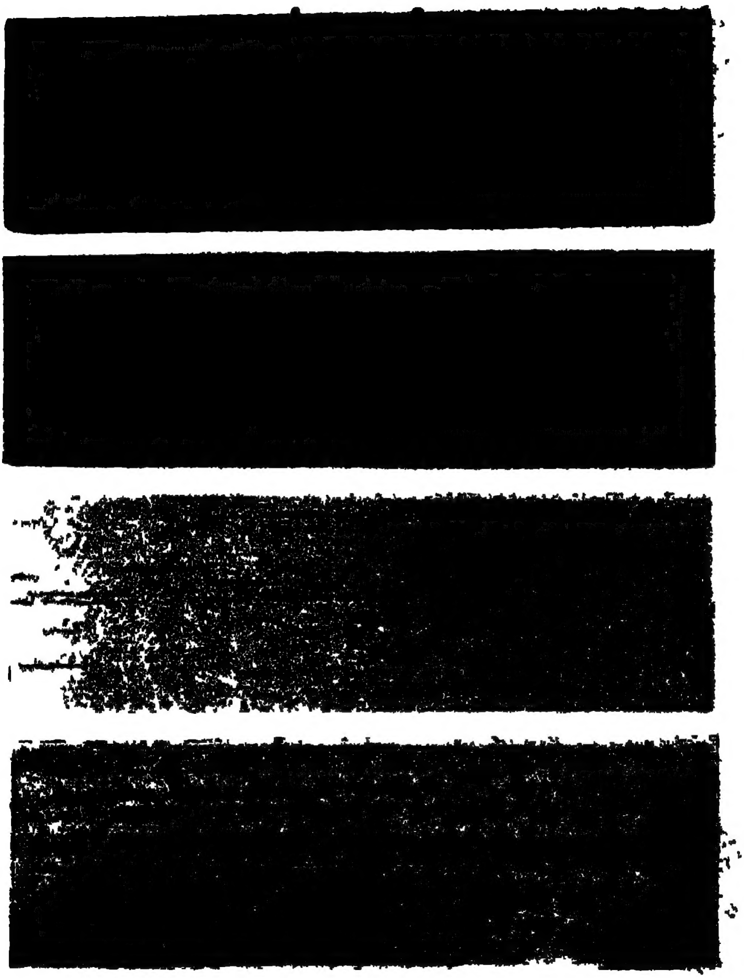
EVERY MAN HIS OWN MECHANIC

VARIOUS WOODS.



1. YELLOW DEAL.
2. DARK WALNUT.
3. MAHOGANY.
4. TEAK.

VARIOUS WOODS.



5. KINGWOOD
6. SATIN WALNUT.
7. PINE.
8 FIGURED OAK.

EVERY MAN HIS OWN MECHANIC

A COMPLETE GUIDE FOR THE AMATEUR

TO ALL

CONSTRUCTIVE AND DECORATIVE WORK

INCLUDING

CARPENTRY
JOINERY
TURNING
PAINTING
GLAZING
METAL WORKING
UPHOLSTERY
FRENCH POLISHING
PICTURE FRAMING
FRETWORK
VENEERING
PLUMBING
WOOD-CARVING
PAPERHANGING
PLASTERING
GRAINING
STAINING
BELL HANGING

ETC., ETC.

NEW EDITION

ENTIRELY RE-WRITTEN AND REVISED

By

JOHN BARNARD

FULLY ILLUSTRATED

WARD, LOCK & CO., LIMITED

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PREFACE

THIS volume has been compiled in order to furnish the amateur artisan with hints and instructions regarding all constructive and decorative work that he is likely to undertake in his own home, and to show him clearly and in a thoroughly practical manner how each process is to be carried out, and with what appliances, tools and materials, it is to be done. The simplest operations have been fully and minutely described, for the book is not put forth as a text book for skilled artisans, but rather as a guide for those who are but little experienced in handicraft. The information contained herein will be found to be practical and reliable. It has been gathered chiefly from observation and actual experience by the Author, who is Controller of the Technical Instruction Department of one of the leading Education Authorities.

That ten editions of *Every Man His Own Mechanic* have been sold is in itself sufficient proof of its popularity and usefulness. The original work, which was first published

several years ago, is now issued in completely re-written form, in order that appliances, tools, machines, methods, etc., which have been introduced since its first appearance may be adequately dealt with.

CONTENTS

PART I. HOUSEHOLD CARPENTRY AND JOINERY

PART II. ORNAMENTAL AND CONSTRUCTIONAL WOODWORK

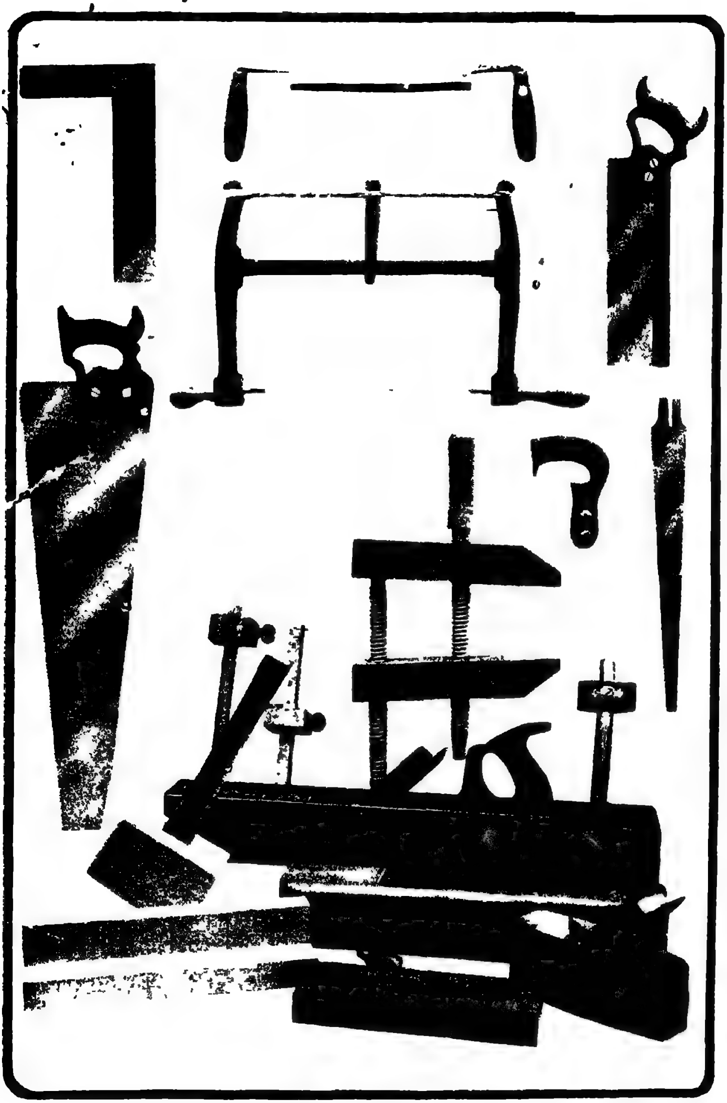
PART III. HOUSEHOLD BUILDING ART AND PRACTICE

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

LIST OF DIAGRAMS, ETC.

Plate I—TOOLS



Try Square, Draw Knife, Frame or Turning Saw, Tenon Saw, Hand Saw, (Sample of Nest of Saws, Wood Clamp, Marking Gauge, Cutting Gauge, Mortise Gauge, Mallet, Trying Plane, Jack Plane, Mitre Blocks, Smoothing Plane, Rebate Plane

Plate II—THE SAW

(1) Ripping a plank; (2) Manner of holding tenon saw; (3) Use of hand-saw; (4) Cutting a tenon

EVERY MAN HIS OWN MECHANIC

INTRODUCTORY

This book is not put forth as a text-book for skilled craftsmen, but rather as a guide to those who are inexperienced and therefore stand in need of advice and assistance. At the same time, there are many who, from the nature of their employment or training, already possess the faculty of general "handiness." To these also the information contained herein will be valuable on account of the attention given to unfamiliar matters of detail, and especially because it will enable them to grasp at once the differences between the processes with which they are already acquainted and those connected with the new work in which they propose to engage.

Apart from the fact that manual work forms in itself a pleasant, healthful and interesting occupation for many who have a natural bent towards it, there will be always a large number of people who will insist on doing their own work as far as possible. Want of manipulative skill and the dexterity of the professional workman may be, and often is, largely compensated for by the exercise of care and patience. Ignorance of correct methods is, however, a far more serious matter and, whilst nearly always leading to unnecessary annoyance and waste of time, must in many cases end in total failure. On the other hand, the simple fact of the existence of so many amateur workers clearly indicates the advantage of being able to effect repairs or carry out simple constructive work in the home or garden. Besides, it is not impossible that emergencies may arise when a practical knowledge of such work may prove to be of the utmost

value and importance, as for instance in the case of the colonist or the dweller in an outlying district.

A book of this kind may, however, be regarded from another point of view. In every household there are many things which require attention, but are so trivial in themselves that the inconvenience experienced and the expense of calling in outside help are altogether out of proportion. It is particularly in such matters as these that the amateur will realize the advantage of a practical knowledge of the work required to be done. It must be remembered that, more than anything else, it is the cost of labour and the value of time which make repairs and similar work expensive, and that if a man has sufficient energy and will to do such work for himself as far as practicable the pecuniary benefit derived must in itself be considerable. More than this, the amateur who is capable of helping himself by carrying out minor repairs will often save much time, for he can usually attend to the matter at once instead of waiting the convenience of the workman. Another, if smaller, point is that workmen cannot always attend at times which will fit in with the general household arrangements. There are no doubt occasions when outside help has to be resorted to, but even in these cases, an acquaintance with the details of practical work will still be of service as it will enable an opinion to be formed as to the probable cost of the job and also as to the quality of the workmanship put into it.

While manuals of this kind are chiefly consulted for the purpose of obtaining information with regard to some particular piece of work which it is desired to carry out, it must not be overlooked that there is another and hardly less valuable use to which they may be put. The reader to whom the type of occupation here dealt with appeals will no doubt, in turning over the following pages, and without waiting for breakages or dilapidations to occur, see the desirability of effecting at little expense some slight alteration which will add to the comfort or convenience of the home. The book is, then, intended to be above all suggestive, and as such it may awaken in the minds of many an interest in a sphere of activities from which their education and mode of life have hitherto drawn them away. In any case it is believed that the development of a proper sense of pride in the home and of a dislike for the dilapidated and neglected dwelling cannot fail to result from the efforts of the amateur in the directions indicated. If this be so, one of the main purposes of the work will have been fulfilled.

PART I

Household Carpentry and Joinery

CHAPTER I

THE VARIOUS WOODS USED IN CARPENTRY AND JOINERY

Various Kinds of Wood.—Before entering on a description of the different tools and processes employed in carpentry, it will be well to consider the various kinds of wood that are used, and the purposes for which each is specially adapted. Experience will show that wood which is admirably fitted for one kind of work is by no means suitable for another. The prices, too, of different sorts of wood differ as much as their qualities, and it is desirable that the amateur artisan should become acquainted with these to some extent, that he may know what he is about when he is making purchases. A knowledge of the prices of the different kinds of wood used in building and furniture making will also be useful to him in other ways. For example, if he intends to put up even so unambitious a structure as a weather-boarded shed, he can, after making his plans and working drawings, calculate to a nicety the quantity of wood that will be wanted, and its cost at the timber yard; and if he finds that the cost will be greater than was anticipated he can modify his plans and the mode of structure accordingly.

Working Drawings.—The amateur artisan will be well advised in all cases to prepare careful plans and working drawings to scale of any piece of work which he may be about to undertake, whether large or small, before he attempts to put it in hand. The worker in wood or stone or any other building material will be led to appreciate the importance of making correct and careful plans and drawings when he finds how helpful such drawings are in the actual performance of his work. The whole mode of procedure—what he has to do and how he must do it—will be clearly fixed in his mind before he even touches the material which he is about to work up into the desired form or object, and he will always find the execution of the work to be quicker or slower, according to the

extent to which he has previously worked out his plans in his mind, and committed them to paper.

Full particulars as to the sizes in which the various woods can be obtained will be given later. In the present chapter it is proposed to give only some idea of the nature of each kind of wood and the purposes for which it may be used.

Pine, Deal or Fir.—The general name of Pine or Deal is given to the timber yielded by a great variety of cone-bearing trees, although the deal or pinewood cut from different trees varies considerably in quality and general utility. Fir is the general term given by timber merchants to all timber belonging to this species entering this country from European ports. Yellow pine is imported from America. It is very light, straight-grained, soft, and free from resin. Deal may be broadly distinguished as Red or Yellow Deal—for the names are indifferently used—and White Deal. In one kind, the ground colour of the wood is yellow, diversified with markings of pale red; in the other kind, the wood is of a whitish colour, whence its name. White Deal is obtained from the Spruce Fir, and Red or Yellow Deal from the "Scotch" Fir and Norway Pine. The grain of the Yellow Deal is generally very straight and free from knots, and the wood is very durable, though it is soft and easily worked. This renders it peculiarly appropriate for all building purposes, whether in the construction of houses or ships. The great height and straightness of the pine renders it well suited for the masts of ships. It can be planed to a fine finish, and when stained and varnished the timber presents a handsome appearance for joiners' work in houses. White Deal is an inferior wood, harder and not so straight-grained as Yellow Deal, and it is generally full of knots. The variety known as Silver Fir is used for flooring, and also in the manufacture of the cheaper kinds of household furniture. Varieties of Deal are generally distinguished by the names of the countries from which they are imported. The best kinds come from Prussia, Russia, Sweden, Norway and America. In purchasing timber the amateur must be careful to specify the kind of Deal that he requires, whether White or Yellow. To be acquainted with the difference in the appearance of the two kinds will prove of advantage to him in making his selection.

Pitch-pine.—This is a heavy resinous wood imported from the

Southern States of North America, chiefly from Georgia and Florida. It is very strong and is showy in appearance, being of a rich yellow colour with beautifully figured grain. It is used largely for school and church furniture and also for general constructional purposes. Owing to the large amount of resin in the wood, it is extremely difficult to work and all cutting tools have to be liberally oiled or greased in order to prevent them from clogging. Pitch-pine shrinks very much and unevenly, and full allowance for this must be made in construction. It does not hold glue well and the solvent effect of the resin soon destroys any coating of paint. Varnish can be applied if the wood is first given a coating of size.

Larch is a useful wood for outdoor purposes, such as posts and fencing, for which it is often preferred even to oak. It will also last well under water, and is therefore very suitable for piles. The colour of the wood varies from yellowish white to reddish brown, but after long exposure it becomes almost black. In working it is hard and tough. The grain, however, is straight and even. Larch shrinks and warps very much in seasoning.

Whitewood or Bass.—This wood is also known as canary wood, on account of its colour, which is a greenish yellow. It is imported in large quantities from North America, where it is commonly known as Yellow Poplar. For indoor purposes it has many advantages. It can be obtained in any ordinary lengths and in widths from 12 in. to 24 in. It is cheap, easy to work, straight in the grain and of uniform texture, and quite free from knots and imperfections. It planes to a good smooth surface and takes stain or polish well. On the other hand, it shrinks freely and is liable to warp or cast. It is not very strong, being liable to break off short. It has been correctly described, however, as an all-round useful wood.

Sequoia.—This handsome-looking wood is obtained from the *Sequoia gigantea*, a species of pine of great size common in California and the Western parts of the United States. Being of great height and girth the planks sawn from its trunk are of considerable breadth. It is of a reddish tint, not unlike cedar in some specimens, variously marked from narrow stripes in alternate tints, one darker and the other lighter, to broad and well-defined marking of a pronounced character caused by the large size of the rings of which the trunk of the tree is composed.

Its chief use is for panelled work, for which the size and beauty of its veinings render it specially suitable. On account of its great width it is also used for facias and signboards. The wood, however, is brittle, and soft in substance, being readily indented by pressure, and easily damaged by blows. It is therefore ill-adapted for cabinet-making and for household furniture, except for drawer sides, bottoms, and inside work generally, for which it is equal to pine.

Mahogany.—There are several sorts of this useful and ornamental wood, which is brought mostly from the West Indies and Central America. Mahogany is generally distinguished as Spanish and Honduras. Spanish or Cuban Mahogany is darker, and of a closer grain than the Honduras variety. It is imported from the islands of Cuba, Jamaica and San Domingo, generally in logs about 10 ft. in length and from 24 in. to 26 in. in width. The wood imported from Cuba is the most valued on account of its rich colour, and the variety of the figuring gives the wood a very beautiful appearance. Honduras Mahogany is sawn into planks of considerable thickness and the trees are so large that these planks sometimes measure 6 or 7 ft. in width. It takes a fine polish. The better qualities are used by the cabinet maker, the joiner and the ornamental turner. The inferior qualities are in demand with pattern makers, as it is not affected by damp or heat. Honduras Mahogany is also known as Baywood. It is much softer and easier to work than Spanish Mahogany, and is much lighter. It shrinks very little, but will not stand exposure to the weather. In dry situations, however, it is very durable. It holds glue better than any other wood, and for this reason, and also because it is little liable to shrink or warp, it forms the best foundation for veneer work.

Oak.—This wood unites in a remarkable degree the qualities of strength and durability. It is, however, very difficult to work, and soon takes the edge off the workman's tools. The wood is dark in colour and capable of receiving a high polish. It is much used in house-building of the better class for floors, staircases, doors, the panelling of rooms, etc., and also for tables, chairs, sideboards, and other pieces of household furniture. For general usefulness it comes before any other wood. Pollard Oak, which presents a beautiful variegated surface, is valuable for decorative furniture. Much, if not all of the carved work in cathedrals and churches and many ancient dwelling-houses, is

wrought in oak. The broad lustrous stripes that give such marked variety to the surface of an oaken panel is owing to the exposure of a greater or less space of the *medullary rays* which radiate something after the manner of the spokes of a wheel from the centre of the heartwood to the bark. The principal defects of oak are that it is liable to twist and warp, and that it is subject to the attacks of insects. It varies very much in quality, and its strength and durability depend very much upon the soil in which it is grown. Further, the pyroligneous acid which it secretes soon corrodes iron and other metal fastenings, especially in wet situations, and in the process decomposes the tissues of the wood itself.

American oak, sometimes called white oak from the colour of the bark, is known by its reddish tinge. It is lighter and coarser grained than the English variety and is much easier to work.

Wainscot oak is an imported European oak coming chiefly from Fiume, Trieste, and the Baltic ports. The beautiful figuring which distinguishes this wood is obtained by cutting the planks or boards radially from the centre of the log. This has the effect of displaying to full advantage on the surface of the board the "silver grain" or medullary rays, to which reference has been made above. The method of cutting adopted naturally involves a good deal of wastage in converting the log into boards and the cost of the wood is correspondingly higher.

Elm is the wood of a lofty and handsome forest tree, well known in Great Britain, which thrives best and attains the greatest height and growth in moist situations. Elmwood will stand the wet for almost any length of time without decaying, and is therefore useful for all purposes in which immersion in water or exposure to moisture is necessary. For this reason it is used largely for boat building, and where plentiful, for piles. Like oak and other timber however, it soon rots if exposed alternately to wet and dry conditions. It is very tough, cross-grained and difficult to work. It is very strong, and though extremely liable to twist and shrink will stand a great strain before it splits. Nails and bolts may therefore be driven into it without any fear of their loosening. Elm is reddish brown in colour, the heartwood being of a considerably darker tint than the outer or sapwood. It is sometimes beautifully figured and is then much prized by the cabinet-maker.

Walnut.—The wood of the Walnut is extremely useful and

valuable, and is used in the arts for many purposes, of which not the least important is that of the manufacture of ornamental furniture. In olden times it was as much used for this purpose as in the present day, but after the introduction of mahogany and rosewood, walnut went out of fashion, and for some time was only used for making gun-stocks, etc. During recent years, however, it has again come into favour, and is now greatly in demand for dining and drawing-room suites, tables, chairs, couches, and every description of ornamental household furniture, for which it is well adapted by the fineness of the grain, its capability of taking a high polish, and the extreme beauty of the wood, which is of a greyish brown, richly diversified with streaks and veins of black running in all directions. Its chief drawback is in its want of density, which renders it liable to injury from blows and rough usage. It is also somewhat brittle, and lacking in durability. It is as useful to the turner as to the cabinet-maker, and works well in the lathe. It is desirable to get walnut wood from old well-grown trees, for the older the tree the more beautiful and diversified are the markings of the wood.

Black Walnut.—For all kinds of cabinet-work and for fret-sawing the wood known as Black Walnut is the most suitable. Unless well seasoned by kiln-drying, or some similar process, it is apt to warp and split. It will take a beautiful polish, but an excellent effect is produced by plain oiling. This process seems to harden the fibre, and a dead polish will often show better in the work than though it shone like a mirror. This wood ought never to be varnished, for it gives a common look to the article, and never fails to bring out the grain.

Ash.—The ash is a hardy, deciduous tree, generally found in northern latitudes. In colour the wood is greenish white when young, but the grain of timber cut from old trees is often dark and beautifully marked. When in this condition it is frequently used by the cabinet-maker. Its toughness, elasticity and closeness of grain render the wood useful for making the frames of carriages, agricultural implements, felloes of wheels, etc. Handles for hammers, axes and similar tools and billiard cues are frequently made of ash, and it is much used by coopers. When steamed it admits of being bent almost double without breaking, and on this account it is well adapted for curved work. The well-known bentwood chairs are made of this wood.

Hungarian Ash.—This variety is valuable and suitable as a groundwork for marquetry. The value of the wood varies in accordance with its markings, some specimens being so beautifully veined and streaked as to be worth double the price at which ordinary pieces can be procured. The grain is not very close, but disposed in various lines, soft in some spots and hard in others. It is a difficult wood to cut, and is better adapted for backgrounds than for sawing as fret-work. The most convenient way of using it is veneered on other woods, similarly to bird's-eye maple.

Beech is the wood of a hardy deciduous tree, also found in northern latitudes. It abounds in Buckinghamshire—a county which was so called from the Beech trees which covered the sides of its hills. The colour varies; it is mostly light or whitish brown in tint, but is found in all shades of brown, deepening at times to black. This difference in colour is ascribed to the influence of the soil. The wood is fine and straight-grained, and is, in consequence, easily worked. Beech is one of the few woods which can be planed against the grain. The texture resembles that of mahogany, and beech is often stained to represent that wood. It is used in the manufacture of furniture, tables, beds, and chairs being made of it; indeed, the manufacture of beech frames for cane-seated chairs forms one of the principal industries of Buckinghamshire. It may be stained to imitate ebony and rosewood as well as mahogany. It does not readily absorb moisture and consequently warps very little. The framework of machinery, planes and chucks as well as the handles of tools are generally made of beech. Dowel-pins (see p. 94), for jointing framework, are often made of this wood, though more frequently, perhaps, of birch.

Woods generally useful.—Such are the various kinds of wood that are most commonly used in building and the constructive arts, and although the amateur artisan may have occasion to use but a limited number of them, it is as well that he should know their properties and uses. Indeed, if it be possible, it is desirable that he should make a collection of as many kinds of wood as he possibly can, exhibiting their appearance, when sawn only, when worked to smoothness by means of the plane, and when stained and varnished, or polished. This would give him a valuable insight into the texture and capabilities of different kinds of

wood, and would afford him experience, if he should ever undertake any veneering, inlaying or marquetry work.

Ornamental Woods.—In addition to the woods already enumerated, there are many other kinds that are used in the arts, and even in the manufacture of ornamental furniture. As such woods are only required for special purposes, it will be unnecessary to deal with them in the present chapter. Notes on many of them will, however, be found in the section dealing with ornamental woodwork.

Timber for Various Uses.—The following list gives in a summarized form which may be convenient for reference the best timber for various purposes.

(*a*) *For General Construction.*—Oak, Chestnut, Teak, Cedar, Fir, Elm, Walnut, Larch, Pine, Beech, Mahogany, Poplar.

(*b*) *For Scaffolding, Ladders, etc.*—Acacia, Spruce Fir.

(*c*) *Timbers durable in wet places.*—Oak, Alder, Teak, Acacia, Elm, White Cedar, Larch, Iron bark, Beech, Plane, North American Plane.

(*d*) *Timbers durable in dry places*—Oak, Chestnut, Olive, Mahogany, Larch, Willow, Deal, Cedar, Pine of all kinds, Maple, Ash, Plane, Poplar, Teak, Cedar, Sycamore, Acacia.

(*e*) *For Patterns.*—Deal, Alder, Pine, Mahogany.

(*f*) *Hardest English Woods.*—Box, Oak, Elm, Walnut, Beech.

Many of these woods have been fully described in the account given above of the various kinds of timber used in building, carpentry and joinery.

CHAPTER II

TIMBER FOR GENERAL USE; ITS SELECTION

In the present chapter we shall proceed to deal with the general qualities of timber, its seasoning, shrinkage and warpage, defects, the trade classification of timber, market forms, commercial sizes and terms, and the selection and purchasing of timber. Reference will also be made to manufactured articles which can be procured from the timber merchant, such as mouldings, doors, window sashes and rails, trelliswork, posts and fencing.

Timber, Notes on Strength and Density of.—In accordance,

then, with the course that has just been marked out, a few notes on the strength and density of timber may not be out of place here. These may be stated as follows:—

(1) The longer the time that a tree is growing, provided always that it has not passed maturity and begun to decay, the heavier and denser its wood becomes.

(2) Generally speaking, the heavier the wood the stronger it is.

(3) The strongest timber is always found in the lower part of a tree.

(4) The straighter the grain of the timber the stronger the wood.

(5) The sapwood between the bark and the heartwood is not so strong as that which lies between the sapwood and the heart, or in other words the strongest timber lies between the heart and the sapwood.

Timber, Seasoning of.—All timber should be well seasoned before it is used by the carpenter, for whatever purpose it may be intended; that is to say, after it has been felled and sawn a sufficient time should be allowed for it to dry, and thus become entirely free from sap and other moisture.

Timber should not be felled until it is of mature age. The best season for felling is in the depth of winter when the sap has withdrawn to the roots. The trunk of the tree is then less full of sap than at other times. When felled and stripped of its bark, the tree should be squared or sawn into logs, and placed in running water, or where it is fully exposed to the influence of sun and air. When removed from the water wood should not be allowed to dry too rapidly. In seasoning, timber will lose from one-fourth to one-half its weight when felled, owing to the evaporation of moisture that it contains. The more porous or less dense the wood, the more sap or moisture it contains, and thus it is that a heavy wood loses less than a light wood in weight when seasoning, *e.g.* oak loses less in drying than fir.

Timber, Artificial Modes of Seasoning.—There are artificial means of seasoning timber, consisting chiefly in exposing it to the action of steam or boiling water, but wood thus heated, although it is not so liable to shrink as timber dried by exposure to the weather, has not the elasticity and toughness of the latter. Sawn timber of whatever size it may be—that is to say, whether in the form of planks, deals, battens, or boards—during the

process of seasoning is stacked in such a manner as to admit of the free passage of air throughout the pile.

Timber, Selection of.—The better seasoned the wood, the better and more durable will be the articles that are made from it. It is true that seasoned wood is harder and not so easy to work as unseasoned wood, which contains a considerable amount of moisture while the former is tough and dry. It does not follow that the wetter wood is the easier it is to work, as any one may prove for himself by trying to put the saw through a piece that is thoroughly soaked with water. Good wood, or "best timber," is that which is straightest in the grain and freest from knots. In selecting timber for joinery, care should be taken to avoid any piece that has a knot at the edge, as the knot will be loosened in working and often fall out, causing much disfigurement.

Shrinkage and Warpage.—The bad effect of using wood which has not been properly seasoned is particularly noticeable in the modern cheaply built house in badly fitting doors and windows, gaping floor boards, and cracked plaster. The cause of the shrinking of timber is the drying up of the moisture which in its natural state fills its pores. In the process of seasoning or drying, wood shrinks chiefly in a tangential or circular direction parallel with the annual rings. The outer rings contain the greater quantity of sap and consequently the outer part of the log contracts more than the heartwood. Radial or lateral shrinkage is checked to some extent by the medullary rays. As a result of the various contracting tendencies, splitting of the timber would take place if means of preventing it were not adopted. In order to avoid this splitting the woodman often divides the log into quarters. The shrinkage always follows the direction of the annular rings and is greatest in the outer or sapwood. In the case of a log in which the grain does not run straight from end to end the varying position of the sapwood will cause the shrinkage to be unequal in different parts of the planks cut from the log. Such planks will be inclined to warp or twist even after being planed true. Warpage is often produced by wrong methods of drying. It is particularly likely to occur when the wood has been seasoned by the hot air process. A board or panel which is merely "cast" hollow may sometimes be made flat by the simple process of damping the hollow side.

Timber, Diseases and Defects.—Wood, both in the growing tree and in the converted state, is subject to various diseases and defects which impair its quality.

Wet Rot is caused generally by a fungus which germinates in moist ground round the roots of a tree and, entering them, quickly spreads upwards and destroys the fibres of the tree itself. In the same way it will attack a log left on damp ground. This disease is readily detected by the white filaments running through the timber or by dark patches where the wood, having lost all its ligneous qualities, has become quite powdery to the touch. In selecting timber care should be taken to avoid any which may have either of these appearances.

Dry Rot is also due to a fungoid growth which eats up and destroys all the natural secretions of timber and reduces it to a spongy substance commonly known as "touch-wood." It attacks damp or unseasoned wood in any position, but especially in such places as cellars, floors and roofs, where there is not a free circulation of air.

Timber, built into walls, as in the case of the ends of beams, is peculiarly liable to the disease, and for this reason it is usual to leave an air space on each side of the wood. The presence of dry rot may be known by a musty odour, and also by patches of brown or red colour which appear on the surface of the wood. The only preventive and cure for this disease is to allow free access of air to the beams or piece of furniture which may be attacked.

Foxiness is a term applied to the reddish tinge sometimes found in oak and similar timber. It indicates the commencement of decay of the fibres due to over-maturity.

Doatiness is a similar form of decay frequently noticeable in birch, beech and ash. The patches are usually of a light colour speckled with black.

Heart-shakes are developed in the growth of trees, but become more apparent when the wood is seasoned. They appear as clefts starting from the heart or pith of the tree and running outwards to the sapwood. They are the result of the shrinkage of the old heart layers of wood and are due to old age. If they occur in one direction only the defect is not serious, as the log may be split along their course, but when they are numerous or cross one another, they cause considerable waste of timber.

Star-shakes occur chiefly in the sap-wood and run inwards in a line with the medullary rays. They are due to sudden climatic changes during the growth of the tree.

Cup-shakes or Ring-shakes take the form of clefts between the annular rings near the centre of the tree. They are attributed to various causes, but are probably due to an excessive supply of moisture supplied by the roots during the wet season in tropical countries, as the defect is more generally confined to trees brought from these regions. Cup-shakes are also said to be due to a separation of the layers caused by the loss of nutrition when the young leaves are destroyed by insects.

Rind-galls are caused by the breaking-off of a branch and consequent injury to the bark. Successive layers of sapwood subsequently cover the wound, but the continuity of the fibres is broken and the strength of the timber seriously affected.

Upsets are due to damage done to the fibres by unskilful felling ; the tree being allowed to fall violently upon its end, the fibres are buckled. The fracture can usually be distinguished only when the wood is planed, but then appears as a crack across the grain. Timber thus damaged will break very readily.

Wandering-heart and **Twisted-fibre** are caused by the action of high winds which strain and disturb the fibres of the tree when young. A plank or board cut from a tree which has suffered in this manner is always " cross-grained " and extremely liable to warp and twist.

Timber, Classification of.—In commerce, woods are classified as soft woods and hard woods. The soft-wood class comprises the coniferous trees and, generally, all trees with " needle " or spinous leaves. These trees include pines, firs, spruces, larches, cedars, yews, junipers and cypresses. The wood (with the exception of that of the yew tree) is resinous and has a fragrant odour. The fibre is straight and tough and of even texture. The colour is pale or light tinted.

Trees belonging to the hard-wood class have broad leaves. The wood is non-resinous, the secretions being acid or astringent. It is darker in colour than soft wood and the texture is much closer. Among the more common hard-woods are oak, mahogany, walnut, beech, elm, ash, birch and ebony.

Timber merchants adopt further classifications which vary considerably according to the locality. Timber belonging to the

fir and pine species and coming from European port is usually called **Fir** and is distinguished as white, yellow or red, according to its appearance when converted. Similar wood coming from American ports is known as **Pine.** Amongst wood-workers timber from the European conifers is known as **Deal,** whilst the American variety is usually termed **Pine** or **Spruce.** This confusion of terms tends to make the identification of wood of great difficulty to any but those in the trade.

Timber, Market Forms of.—The following are the trade terms of shape and measurements to which timber is converted for the market.

Log is the name applied to the tree when felled and lopped, but with the bark still on. Sometimes, however, the term is used in connexion with the squared trunk. English timber is usually converted at once into half-logs and when sufficiently seasoned is cut into planks or boards of the full size which the tree will yield. For this reason, English timber may often be seen with the bark on one or both edges of the boards.

Balk is the log roughly squared with the axe or saw. Foreign timber is usually imported in the form of balks except in the case of firs and other soft woods, which are brought into the country already cut up into boards. Uncut balks are sometimes described as whole timber.

Flitch is the half of a balk cut lengthwise.

Planks are sawn timber 11 in. wide and over and from 2 in. to 6 in. thick. In hard wood the name is given to cut stuff upwards of 9 in. wide and 1½ in. thick. Planks are from 8 to 20 ft. in length.

Deal is a small plank less than 10 in. wide and at least 2½ in. thick. It is generally 12 ft. long.

Batten is not more than 9 in. wide and not more than 3 in. thick.

Board is not more than 2 in. thick, and may be of any width over 6 in.

"**Feather-edged**" boards are ordinary boards sawn in halves diagonally, so that they are thinner at one edge than the other, (See "Weather-boarding," p. 373).

Quartering is the term applied to pieces of timber almost square in section, cut from deals or planks, which in fact are quartered, or divided into four. Thus, without making allowance for the saw cut, a plank of 11 in. wide and 2½ in. thick, can be sawn into quartering measuring 2¾ in. by 2½ in.; and a deal of 9 in. in width and 2¼ in. thick can be sawn into quartering measuring 2¼ in. by 2¼ in. Sometimes, however, it is cut into such measurements as 4 in. by 3 in., or 3 in. by 2 in. Quartering is the stuff that the amateur artisan will most frequently use in framing sheds and garden structures, as it is strong enough for all general purposes in putting up buildings of this description.

Scantling is a piece of timber cut or sawn to a small size as for rails, etc., but the term is also generally applied to the dimensions of a piece of timber with regard to its breadth and depth. Thus a scantling may be of any dimensions as regards depth and thickness, and not of regulation sizes as planks, deals, and battens.

Short-ends are pieces of deals, planks and battens which have been cut off in order to reduce these forms of timber to standard lengths. They vary in length from 4 to 8 ft., and though usually of excellent quality may be purchased at low prices.

Poles are straight trunks of young trees free from branches and not more than 8 in. in diameter.

A **Square** of match-boarding or flooring is 100 ft. superficial.

Standard.—European soft woods are sold by the standard hundred of deals. The St. Petersburg standard, the one in general use, consists of 120 pieces, 12 ft. by 11 in. by 1½ in., or 165 cubic ft. The London standard is 120 pieces, 12 ft. by 9 in. by 3 in., or 270 cubic ft.

A **Load of timber** is 50 cubic ft., and is the standard of measurement for most American soft woods.

"**Square-edged**" is a term applied to timber sawn to uniform width and thickness.

"**Waney**" is a term used to describe boards cut from the log and imported with unsquared edges and unequal in width.

"**Deep-cuts**" and "**Deeping**" are terms used in saw-mills

Plate III PLANES

(1) Use of jack plane; (2) Shooting edge of board with trying plane
(3) Use of shooting board; (4) Use of toothing plane in veneering
(5) Smoothing plane

Plate IV GROOVING AND RABBETING

(1) Cutting groove with plough. (2) Use of router for stringing and banding. (3) Cutting a rabbet.

in connexion with the cutting of planks or deals through their width. When a plank 3 in. thick is cut in this way the boards are described "one deep cut" boards; similarly sawn into three boards 1 in. in thickness, it is "two deep cuts"; into four boards, "three deep cuts," and so on up to "nine deep cuts" for picture backing. In all cases the boards are referred to in the trade by the number of cuts and not by the thickness. As allowance must be made for the saw-cuts, the actual thickness of the boards is not strictly proportionate to that of the whole plank. Pine planks purchased from the timber merchants without cuts or with less than three cuts are subject under trade regulations to a charge of 2½ cuts to each plank. The charge for "deep-cuts" varies according to the length of the plank.

"Flat cuts" and **"Flatting"** refer to cutting a plank through its thickness. Thus, if stuff 3 in. square is required, it is described in the case of a 9-in deal as "two flat cuts," and so on for all other sizes. "Flatting" is usually charged at per 100 ft. run according to the thickness of the plank.

"Three-ply" is composed of three thin layers of wood glued together under pressure. The grain of the centre layer is laid at right angles to that of the other two, so as to give additional strength and avoid warping. "Three-ply" is much used for drawer-bottoms, panels and fretwork. Ply wood is usually sold in thicknesses varying from ⅛ in. to ¼ in. For special purposes, however, it may be obtained up to 1 in. in thickness. It may also be 3-ply, 5-ply, or more; in the case of the 1 in. wood, used for exceptionally good work, it is sometimes as much as 15-ply.

Fretwood, used, as its name implies, principally for fretwork, but also useful for many other purposes, is specially prepared wood obtainable in thicknesses varying from ⅛ in to ¼ in. The various kinds of wood so prepared will be fully dealt with in the chapter on "Fretwork."

Veneers are cut from the log and are either "knife-cut" or "saw-cut." The former description are cut about thirty-six to the inch, and the latter considerably thicker—about twelve or fourteen to the inch. They are usually sold by the leaf or sheet. Further reference to these beautiful woods will be made when dealing with *Veneering, Marquetry* and *Inlaying.*

Selection and Purchase of Timber.—In the selection of timber the amateur should look chiefly for general uniformity in the appearance of the wood, even texture and colour, firmness and, in the case of freshly planed wood, for a soft lustrous surface. Wood which shows marked variations of colour, excepting that between the heartwood and the sapwood, or an uneven or twisted grain, or which seems soft and sappy should be discarded, as should also pieces showing many knots or shakes or a great deal of resin. Good wood which has been properly seasoned should retain the odour which is distinctive of the tree from which it has been cut. Experts are influenced considerably in their selection of timber by its smell, but even the amateur is familiar with the resinous odour of pine, the aroma of cedar wood, and the acrid smell of oak. Teak, in particular, has an odour which is quite different from that of any other commonly known wood, being extremely pungent.

As already stated in explanation of the terms "Standard" and "Load," soft woods coming from European and American ports are sold respectively in these quantities.

Hard woods are sold generally by the foot super at 1 in. thick, e.g., a board 12 ft. long by 12 in. wide and 1½ in. thick would contain 18 ft. of inch wood. They are also sold by the load of 50 cubic ft., by the log according to cubic contents and in the case of valuable woods, by weight.

The amateur, however, who, except in special circumstances, will require much smaller quantities than those mentioned above, will as a general rule obtain his material either from one of the firms of timber merchants advertising in the trade journals or, in cases where the quantity required is very small, from the local builders' yard. In this way, he will purchase his timber by the foot run. For general purposes and rough work he cannot do better than to lay in a small supply of the "short ends" to which reference has already been made. These may be acquired very cheaply, and, if instructions are given for them to be delivered sawn into various sizes such as ½ in., ¾ in., and 1 in. board, they will often prove useful. If properly stacked in a dry place, these boards will improve by keeping. For a small extra charge, the boards will be sent home planed by machinery on one side or both sides, and with the edges "shot" straight. In this way much labour will be saved, whilst the result will be far better than can be obtained by hand. This remark applies even more particularly to the various hard woods which the amateur may purchase.

In calculating the quantities required for any particular piece of work, full allowance, about 25 per cent., should be made for wastage, and the wood should then be ordered in bulk. No economy is effected by specifying the various lengths required, as the odd pieces cut from the lengths, though left in the timber yard, are charged at the full price. When comparing the prices of various firms, care should be taken to ascertain whether the cost of carriage is included, as this may be a considerable item.

Floor Boards, which will be found useful for shelving and many other purposes, besides that of flooring, are sold by the "square" or half "square," and, in smaller quantities, at per foot superficial. In the latter case, however, the amateur must be prepared to pay at somewhat higher rates. The thicknesses of such boards vary from ⅞ in. to 1¼ in. In calculating the quantity of wood required for any piece of work, it is important to remember that the widths quoted in trade price lists are taken as in the rough, before the wood is seasoned or planed. When finally prepared for use, square-edged flooring boards, nominally 7 in. in width, hold up to about 6⅝ in., and a square (100 sq. ft.) will cover not more than 95 ft., even when carefully laid.

Match-boarding may be obtained in thicknesses varying from ½ in. to 1 in., and is usually 6 in. in width. It is much used for lining walls, etc., and often takes the place of plastering. One edge of the board is tongued or rebated on both sides so as to leave a narrow slip which enters a groove in the board placed next to it. A bead is sometimes run along the edge just above the tongue, so as to break the joint or, in other words, to render the joint between the two boards less conspicuous. When the match-boarding is afterwards to be painted it is often preferred with V-jointed edging in place of the beading. The beadings or V-joints may be on one side only, or on both sides of the board.

Mouldings.—Mouldings, whether in architecture or joinery, are used to relieve plane surfaces by the contrast of light and shade produced by means of curved forms which follow the lines of the object and bring them into prominence.

An immense variety of mouldings are used both in the building trade and in cabinet work. They serve many purposes, and occupy many positions, as, for example, within the panels of doors, along the tops of skirting boards when the boards themselves are not finished with either moulding or beading, around

the frames of doors and windows, as sash bars for the reception of glass and in window frames to keep the sashes in place.

Mouldings may be either "stuck" or "planted." A "stuck" moulding is wrought in the substance of the framing itself; a "planted" moulding is worked separately and fastened around the frame. Small mouldings, such as beadings, should always be stuck; the larger forms are usually planted.

Bolection mouldings rise above the face of the framing, over the edges of which it is rebated, so as to form a narrow projecting ledge between the frame and the curved part of the moulding (Pl. A.).

It would be beyond the scope of the present work to enter into a description of the particular forms of mouldings or their classification, but a few examples of those used for modern purposes, and obtainable from any large firm of wood-workers, are given in Pl. A.

Architrave mouldings, for nailing to the inner faces of window frames and to both faces of door frames, should be large and bold in design, as shown at 1. *Cornice mouldings* (2) should also be large and well defined. For edging the panels fixed in the frame-work of doors formed by the stiles and rails, the finer *panel mouldings* (3) should be used. The effect of these is to soften the abrupt change of level and break up the flat surfaces. *Bolection mouldings* (4) are used in a similar position, but are designed to give a greater apparent depth to the panel and to increase the thickness of the framing. *Friezes* or *picture rail mouldings* are shown at 5. Patterns (6) are *beadings*. Other beadings, suitable for the capping of match-boarding carried some distance up a wall from the flooring, can be obtained, and may be used either as a plain beading or as the slip placed on either side of a window frame to keep the sashes in their proper places. Examples of *cabinet mouldings* are given at 7.

Picture frame mouldings (8) may be obtained in endless variety in oak, walnut and other suitable woods.

As showing the extent to which wood is at the present day wrought by machinery, it may be mentioned that certain of the large joinery firms issue specifications in accordance with which they undertake to supply ready for immediate use the whole of the woodwork necessary in building an ordinary cottage or villa from the joists and flooring to the timbers and laths of the roofing, and including doors, window frames, stair-cases and stair railings, mouldings and other interior fittings. It is improbable that even the most ambitious amateur will ever under-

take the building of a complete cottage, but the mere knowledge of the fact that such material is always available, either in large or small quantities, may be of use to him in minor operations. The amateur artisan who may desire to erect a green-house or bicycle shed cannot do better than obtain from one of the large firms advertising in the various trade journals a current price list showing the rates at which he may purchase timber wrought to convenient size and form for the required purpose. By so doing he may be able to save himself much heavy labour and, what is often of more importance, to considerably shorten the time required for the constructional part of the work.

CHAPTER III

TOOLS AND HOW TO USE THEM.

In the following pages the tools used in carpentry and joinery are classified according to their purposes and modes of action. The manner of using them is also fully explained.

With regard to tools, it may be well to say at the outset that our attention will be confined strictly to those which will be of service to the amateur and which are required for the performance of work well within the scope of the present volume. Power-driven tools, as well as those necessary for large operations such as the sawing and planing of rough timber, will therefore be excluded from consideration. Similarly, no mention will be made of appliances used only in particular branches of the various trades and requiring, in many cases, such a high degree of manipulative skill and precision as is expected from the professional workman. With this limitation, our list will be sufficiently extensive to cover the whole range of work in which the handy man is likely to engage. Due note will also be taken of the many time-and labour-saving appliances introduced in recent years.

Whilst recognizing that any classification of tools must be made on arbitrary lines, the following arrangement into groups of tools used in carpentry will be found convenient for reference :—

I. Striking Tools.

1. *Tools used for striking only, such as hammers and mallets.*
2. *Tools used for striking and cutting, such as hatchets, axes, adzes, etc.*

II. **Saws.**

III. **Rasping Tools, or Tools that act by Abrasion,** *e.g., rasps, files, scrapers, etc.*

IV. **Paring Tools.**

1. *Planes of various kinds, for smoothing, moulding, etc.*
2. *Spoke-shaves and draw-knives.*
3. *Chisels and gouges.*

V. **Boring Tools.**

1. *Bradawls, gimlets, and augers.*
2. *Braces and brace-bits.*

VI. **Holding or Grasping Tools.**

1. *Pincers and pliers, nippers, spanners and wrenches.*
2. *The vice, including hand-vice, bench-vice, etc.*

VII. **Tools for Guidance and Direction in Laying-off and for Testing Work.**

1. *Rules and chalk line.*
2. *The square, bevel, gauges, mitrebox.*
3. *Spirit-level, plumb-level, straight-edge.*
4. *Compasses, dividers, callipers.*

VIII. **Miscellaneous Tools.**

Screw-driver, nail-set, scribers, rimers.

IX. **Useful Aids in Household Carpentry.**

Striking Tools.—Taking the tools necessary to the amateur artisan in the order above given, we have first to deal with **Hammers.** Of these, the amateur should possess two—an ordinary joiner's hammer, commonly known as a Warrington hammer (Pl. VIII), for heavy work, and a light hammer for use with brads and small nails. A useful addition for general domestic purposes might be made in the shape of an American adze-eye or claw-hammer (Pl. VIII). For veneering, a special kind is required, but as this is useless for any other purpose, its consideration may be deferred until we are dealing with that branch of ornamental woodwork.

The handle of the hammer should be grasped at a short distance from the end, as shown in Pl. XI, and a few effective blows rather than many taps should be given. With a very little practice, the amateur will find the driving of a nail to be an easy matter. The important thing to remember is that in order that the stroke may fall perpendicularly upon the head

of the nail, the hand and wrist should not be depressed below the level of the nail. Any one who has watched a carpenter engaged in nailing down floor boards will have observed that every now and then he will stop to rub the face of the hammer on the boards already fixed. This is done for the purpose of cleaning the hammer. This cleaning is absolutely necessary, and the amateur will do well to learn the lesson and, before attempting to drive a nail, assure himself that the face of the hammer is quite free from grease or dirt, as the presence of either will render the straight driving of a nail quite an impossibility. The face of the hammer should, moreover, be perfectly flat; after being used for some time it is apt to get rounded, especially if it be of inferior quality. A small hole should be made with the bradawl or gimlet before the nail is driven in. This is more particularly necessary when the presence of knots or hard grain in the wood may give the nail a tendency to bend.

It may seem somewhat superfluous to remark that hammers are meant for driving nails, striking punches, etc., and not for hitting wood; but it unfortunately happens that the amateur, and the artisan too, is sometimes given to using the hammer for striking the handle of his chisel when mortising or the screw-driver in getting out obstinate nails, much to the detriment of the handles of these tools, which are bruised and split by the blows of the hammer, and thereby rendered unfit to be held in the hand for cutting, in the case of the chisel, or for turning screws in the case of the screw-driver. Wood should always be struck by wood when it is to be struck at all, and when it is necessary to strike the handle of a chisel or screw-driver it should be done with a wooden mallet.

The most convenient form of the **Mallet**, which is merely a wooden hammer, is that of the square American pattern (Pl. I). The head should be about 6 in. long and the face $2\frac{1}{2}$ in. by $3\frac{1}{2}$ in. In addition to its use for striking wooden-handled cutting tools, the mallet will be found to be of service in knocking together mortised framework.

The mallet is held in the same way as the hammer, but rather higher up the handle, as the head is larger and heavier. In striking any tool with the mallet care should be taken to deliver the blow so that the end of the handle of the tool is hit with the centre of the face of the mallet (Pl. VI).

Adzes and Axes.—The tools that are used for cutting as well as striking, the blows of which sever or split as well as drive

forward are the adze and axe, or hatchet. The adze is not likely to be required by the amateur; it is used chiefly by shipwrights in shipbuilding, and sometimes by the carpenter. It is also employed in dressing logs of wood or trunks of trees into a rough, square shape, so that they may lie conveniently on the cross-pieces of a saw-pit for cutting into planks, etc. It is held somewhat the same as a hoe, the operator standing on the wood and chipping away the surface, bringing the edge of the blade towards his foot. Shipwrights often inflict severe wounds on their feet with this tool, the edge of which, to be of any use at all, must be nearly as keen as that of a razor.

Axe or Hatchet (Pl. V).—It is with the axe or hatchet that the amateur artisan is more immediately concerned, and having regard to the variety of ways in which it can be used, it is a tool which he can hardly do without. In framing timber it can be used as a hammer, and for sharpening stakes or cutting down timber to the size required in the rough, or for splitting pieces of wood, it is invaluable. It should be kept well sharpened, for a blunt axe is useless for any purpose other than that of splitting firewood.

Good axe-heads are generally sold by weight. The smaller sizes weighing about $1\frac{1}{2}$ lb. or $1\frac{3}{4}$ lb., will be found most generally useful by amateurs. For felling trees, a heavier axe is used, the blade of which is longer and narrower in proportion, and partakes more of the form of a wedge than the ordinary hatchet.

For ordinary purposes the axe must be grasped with the right hand, at a distance of about one-third from the end of the handle; but the position of the hand will be regulated in a great measure by the material with which the edge is brought into contact, or the weight of the blow that it is desired to strike. Thus, to deliver a heavy blow, the handle must be grasped close to the end, but to give a light blow the hand must be moved along the handle until it has nearly reached the head. When turned, the flat part of the head may be used in place of a heavy hammer or mallet in knocking the parts of any piece of framing into place, but on no account should it be used for driving nails. If at any time the amateur finds it necessary to drive large nails, he should provide himself with a heavy hammer of the kind used by carpenters for rough heavy work. In chopping a piece of wood with the hatchet—as, for example, in sharpening the end of a stake to be driven into the ground—the end to be sharpened should be placed on a trestle—a description of narrow stool—

and held by the left hand, which should be kept well out of range of the hatchet. A carpenter will use the axe for shaping a wedge out of a short piece or block of wood, but the amateur is recommended to do this with the paring chisel, lest he should injure his hand with the sharp edge of the hatchet. The manner of holding the hatchet and the wood is shown in Pl. V.

Saws.—There are many kinds of saws, but those which the amateur will find sufficient for all ordinary requirements are the Hand-saw, Tenon-saw, Bow, Frame, or Turning-saw and Key-hole-saw. To these, in order to save wear and tear of the hand-saw, a rip-saw may be added. This saw has large, triangular teeth and is used for sawing along the grain of the wood. It is therefore useful for sawing down, or ripping planks, battens and boards, the work being done more expeditiously than with a hand-saw. A useful addition to the outfit would be a hack-saw, for cutting through metal. Fret-saws will be dealt with in another section of the work (see Part II Chap. III).

The hand-saw (Pl. I) is generally useful and will, when necessary, serve the purpose of either a rip-saw or of the much finer kind of saw used by joiners and known as a panel-saw. It should be about 26 in. in length, and have 5 teeth to the inch.

The illustrations in Pl. II show the position of the hand when holding the saw. In grasping of the handle of a saw, all the fingers are passed through the loop of the hand-saw or round the handle of the tenon-saw, the latter being somewhat differently formed. In the case of the tenon-saw, the position of the thumb and the second, third and fourth fingers are shown in the illustration; the first finger is laid along the side of the handle. This position of the first finger assists the worker in a wonderful degree in steadying and directing the saw and in keeping it upright. The elbow of the right arm should be kept well into the right side so as to strengthen the fore-arm, or rather, to keep it as straight as possible and in a direction corresponding to that of the wood which is being sawn.

The wood should be steadied with the left hand or, if it be a short piece, held firmly by it. In sawing down a board on one or two trestles, as the case may be, the right knee and foot should be placed on the board. This will assist in steadying both the wood and the body of the operator. Whether in ripping down a plank or in cutting a piece of wood across the grain, the hand-saw, or any saw of this shape, should be held at an angle of 45° or very nearly so. This will serve as a general guide, though

of course the inclination of the saw must vary in some measure according to the position of the wood and the nature of the work to be done. For example, in cutting a tenon, either with the hand-saw or the tenon-saw, the edge of the saw must be kept parallel as far as possible to the surface of the wood which is being cut. The head of the worker should be directly over the saw, so that the eyes may look down on both sides of the saw. In beginning to make an incision with the saw, the up-and-down motion should be started very gently with very short strokes and no force should be applied until the saw has entered about an inch into the board.

As the saw-cut lengthens, more force may be gradually applied, though only in the downward stroke, as it is in this motion only that the saw cuts; in the upward motion, it should be merely drawn up. The sides of the blade should be upright, or in other words, they should always be at right angles to the surface of the board through which the saw is cutting, for if the blade incline to the right or left to the slightest degree, it is obvious that the friction on the sides will be increased by reason of the cut being out of the proper direction. Care should be taken to avoid short jerky strokes. In the upward movement, the saw should be drawn up to within an inch or two of the point, and in the downward pressed with force against the wood which is being sawn until the wood is within an inch or two of the end of the blade or very near the saw handle. By this means, nearly the whole of the edge of the saw is brought into play. In drawing the saw upwards, it should on no account be drawn through and out of the wood, for in the delivery of the following down stroke the point may be driven with force against the wood and bent in one direction or another, thus seriously jarring and injuring the saw.

The mistakes usually made by the amateur when sawing are: *First*, he forgets to keep his eyes directly over the saw-blade, so that he may see both sides of the blade. It is obviously impossible to saw straight if the back of the saw and the saw cut do not form a straight line on the board which is being cut. *Secondly*, instead of allowing the arm free play and motion and permitting it to form a connecting link between the saw and the body and transmitting the weight of the whole body to the saw, he holds the saw stiffly and applies far more force than is necessary. This also has the effect of binding the saw somewhat to the left and making the work difficult through the amount of friction caused by the blade and the saw-cut being at an angle to the

surface of the board instead of perpendicular to it. When these faults have been corrected by the amateur artisan, he will have advanced considerably in the way of becoming a better workman.

A few hints and cautions yet remain to be given with regard to the operation of sawing. It is well when ripping down a board, or in making a saw-cut of some length, to mark the guide line on its surface with the line and reel (see Pl. XIII), by means of which the line connecting any point in one end with any point in the other is struck perfectly straight and true. If the board be not longer than any straight edge the worker may have, the line from point to point may be ruled in pencil with its aid. Amateurs will sometimes trace a line for a saw-cut by measuring the distance between the edge of the board and the point in its end, and then taking off-sets from the edge along the whole length, at distances corresponding to the length of the straight-edge with which they are going to rule the lines which will together form the line of the saw-cut. Whilst such a plan may answer fairly well if the edge of the board from which the measurements are taken has been properly planed, and is perfectly straight, it is clear that any irregularities in the edge will be reproduced in the line, and the saw, under the pressure needed to carry it past the various angles and turnings, will be subjected to great strain. When, however, the edge has been properly planed, a line parallel to it may be drawn by very simple means. Thus, a carpenter will often hold a rule in one hand, letting just the required length project over the board and rest upon it, and pressing the point of a pencil, held in the other, against the ruler and on the surface of the wood draw a straight line parallel to the edge by moving the hand that holds the ruler along the edge of the board and carrying the pencil along with the other pressed against the ruler and on the board throughout the entire length of the line which it is desired to make. The method may be clearly understood by a glance at Pl. XIII. The important point to be remembered is that throughout the whole of the operation of drawing the line, the rule must be kept perfectly square with the edge of the board, as any inclination must have the effect of bringing the point of the pencil inwards and producing irregularities in the line. All difficulty in this respect can, however, be obviated by the use in the place of the ordinary rule of a crenellated square.

In cutting down a long board, the progress of the saw will be facilitated by inserting a thin wedge in the saw-cut as soon as sufficient progress has been made to enable this to be done with-

out interfering with the movement of the saw. This will be found to relieve the friction of the wood on the sides of the blade. If it be found desirable, the wedge may be moved along as the sawing proceeds. Care should be taken, however, that the wedge is not forced in sufficiently to split the wood. If, owing to rust on the blade or the teeth being worn and in want of sharpening, the saw "hangs" at all, a little oil or tallow rubbed on the sides and teeth will be found to effect some improvement.

Whatever may be the nature of the work, or whether the cut be with or across the grain of the wood, the amateur will do well to bear in mind that no saw-cut should be made without first marking the wood with a guide-line either with chalk or pencil or with a marking-knife. In addition, for safety's sake, it is better when making a long saw-cut to mark the line on both sides of the wood so that, during the operation, the board may be turned over now and then in order that the worker may be sure that the cut is being made exactly in the right direction.

The tenon-saw (Pl. I), like the hand-saw, is indispensable. It is altogether different in make, shape and kind from the hand-saw; for, whereas the latter is pliant, the former is rigid, being fitted with a back which further stiffens it and enables it to retain its rigidity. The tenon-saw, as its name implies, is used largely for cutting tenons that are to enter mortises. More generally, however, it is employed for all purposes in which accuracy is required, as in the construction of parts which have afterwards to be fitted together and connected.

The bow or turning saw (Pl. I) serves a purpose quite different from that of either the hand-saw or the tenon-saw. It will be found necessary when following the lines of curved work.

The key-hole saw and the larger saw of the same type known as the compass saw are used for purposes similar to that of the bow-saw, but their uses, being confined to lighter work, are more restricted. The amateur may obtain a useful nest of these saws in which the three blades are so constructed as to be removable at pleasure and used with one and the same handle. The largest size, shown in Pl. I, is intended to be used as a pruning-saw, the intermediate size as a compass saw and the smallest size as a key-hole saw, being similar in all but heel and tang to the blade used in the ordinary pad-handle. In the common form of key-hole saw the heel of the blade terminates in a long and sharp tang but in the nest of saws a slot is cut in the heel of the blade which passes over the two screws in the upper part of the handle,

seen in the illustration. A cut of the necessary width and depth is made in the handle to receive the blade and the handle is compressed against each side of the blade by the screws as much as may be necessary to hold the blade in a firm grip.

To cut out a key-hole, two holes are bored through the wood by the aid of the brace and bit, and the piece which separates them is then taken out with the key-hole saw. Small circles may be cut in a similar manner. For larger work either the bow-saw or compass saw should be used.

Most amateur carpenters will require to cut a piece of metal at one time or another and, for this purpose, will need what is termed a "hack-saw." The frame may be either solid or made on the extension principle and capable of holding blades of any of the lengths in which they are ordinarily made, 8, 9, 10 or 12 in. The blades are extremely hard and will cut brass or iron with the utmost ease. They are much more rapid in their action than files. For cutting tubes or thin metal, whether copper, brass or steel, blades with fine teeth, from 24 to 32 to the inch, should be used; for ordinary purposes a coarser kind, 14 to 18 teeth to the inch, will be more suitable. The makers urge that a blade should never be used for cutting brass when it has previously been used on cast iron or steel, and that either a special blade should be kept for brass-work or a new saw used.

Rasping Tools.—*Rasps*, generally speaking, are used in carpentry for cutting away or smoothing wood or for finishing off the rough edge left in a circular hole cut with the key-hole saw. A rasp is flat on one side and slightly converse on the other and covered with fine projecting points. The ordinary wood rasp is rougher or coarser than that used by cabinet-makers. 'A very convenient rasp for general use is that used largely by motor body builders, and known as the "New Registered Rasp" (Pl. VIII).' There are three different finenesses of cuts on this tool. One half is a fine taper with thin edges suitable for getting close into the work, the other half is a full half-round, specially useful in hollow work. *Files* are used for cutting metal and sharpening saws. The surface of the file is ridged with fine lines cut into the metal. In section they may be triangular, round or flat. The last-mentioned are needed for cutting the wards of a key, or a deeper slot in the head of a screw.

A very much improved file or rasp has recently been introduced in the shape of the "Dreadnought" milling file. Its action even

upon hard metals like iron or bronze is very rapid, and it leaves a perfectly smooth surface. Ordinary files, when used upon soft metals such as copper, brass, lead and aluminium, very quickly clog and cease to be effective. A great advantage of the "Dreadnought" file is that it is self-clearing. For this reason it would also be found useful in dealing with hard wood.

For use in cabinet work an excellent rasp may be made by the amateur in a few minutes by tapering a round stick about 12 ins. in length, making a saw cut rather more than half way down from the narrow end and wrapping it round with glass-paper. The edges of the glass-paper are inserted in one side of the saw cut. The holder is shown in Pl. B, Fig. 9, and the manner of using the rasp in Pl. V.

In using large rasps or files, whether for wood or iron, the work should be held in the vice or otherwise firmly fixed, as it is desirable to use both hands when possible. The handle of the tool should be grasped by one hand while the other is pressed, but not too heavily on the end or near the end of the blade so as to lend weight to the tool and additional effect to its powers of abrasion. The flat side of the rasp may be used for any kind of work, but the rounded side will be found more handy for rasping down the edge of a round hole so as to give it a bevelled or rounded surface.

Glass-paper, the use of which in carpentry is often disparaged as being unworkmanlike, is far too useful to be omitted from the woodworker's outfit. It is manufactured in four grades, numbered from 3 to 0, according to the fineness of the particles of glass with which the surface of the paper is covered. If used without a proper rubber it will render the surface uneven by wearing away the material in some places more than in others, a defect which becomes particularly noticeable if the wood is afterwards polished, and will also give an amateurish appearance to the work by destroying the sharpness of the edges.. Rubbers for use with glass papers are obtainable at the cost of a few pence, but failing these a piece of perfectly flat wood or cork, about 4½ in. by 2½ in by 1½ in, will answer very well. They should be used in all cases when dealing with flat surfaces. Glass paper should not, however, be used in any case for finishing off the surface of oak and similar woods, as it will destroy the ornamental character of the grain. Such woods should in all cases be left smooth from the plane.

Scrapers, though sometimes classified with abrading tools,

only fall into this category when improperly sharpened. When the scraper is in good condition, it is a genuine cutting tool, and it should therefore be dealt with as such. A description of this tool and particulars with regard to the manner of its use will be found on p. 60.

Paring Tools.—Paring tools, or tools which are used for cleaning away the rough surface left by the teeth of the saw and rendering wood smooth and even, or otherwise for cutting wood into various shapes and forms, are frequently called edge-tools, as they present a sharp, keen edge. Indeed, if they are blunt in the least degree they are not fit for use. An artisan at his work will frequently stop to rub his plane-iron or chisel on the oil-stone in order to sharpen it. An amateur rarely attaches sufficient importance to the necessity of having a keen edge on his cutting tools and this accounts for much bad work. Not only is it well to buy none but good tools, but also to see that they are always kept in good order, perfectly clean and free from rust. The edge should be whetted as soon as any sign of dullness is observable. Special instructions as to the manner of sharpening the various tools and particulars of the various appliances for doing this will be given further on.

The tools comprised in the first group of paring tools are **planes**. The only planes, however, which are absolutely necessary to the amateur are a jack-plane and a smoothing plane. To these if desired a trying-plane may be added, as it will be found useful for long joints and for first-class work, and also a rabbet or rebate plane. Special circumstances may of course arise which will require the use of other planes, but not till then should the amateur think it necessary to include them in his outfit.

The **jack-plane** (Pl. I.) is from 15 to 18 in. long, 3 in. broad and about the same in depth. The iron is 2¼ in. wide. Near one end is a handle, or toat, projecting upwards, and towards the other a hole for the reception of the plane-iron, which is held in its place by a wooden wedge. Planes of this description, and smoothing planes also, are furnished with double irons; that is to say, two irons held together by a short screw, one iron with a sharpened edge which takes off the surface of the wood in shavings and another, known as the break iron or cap-iron, which is attached to it by a screw. The edge of the break-iron, which is slightly bent, is placed at a very short distance from the edge of the cutting-iron; it serves to support and strengthen the

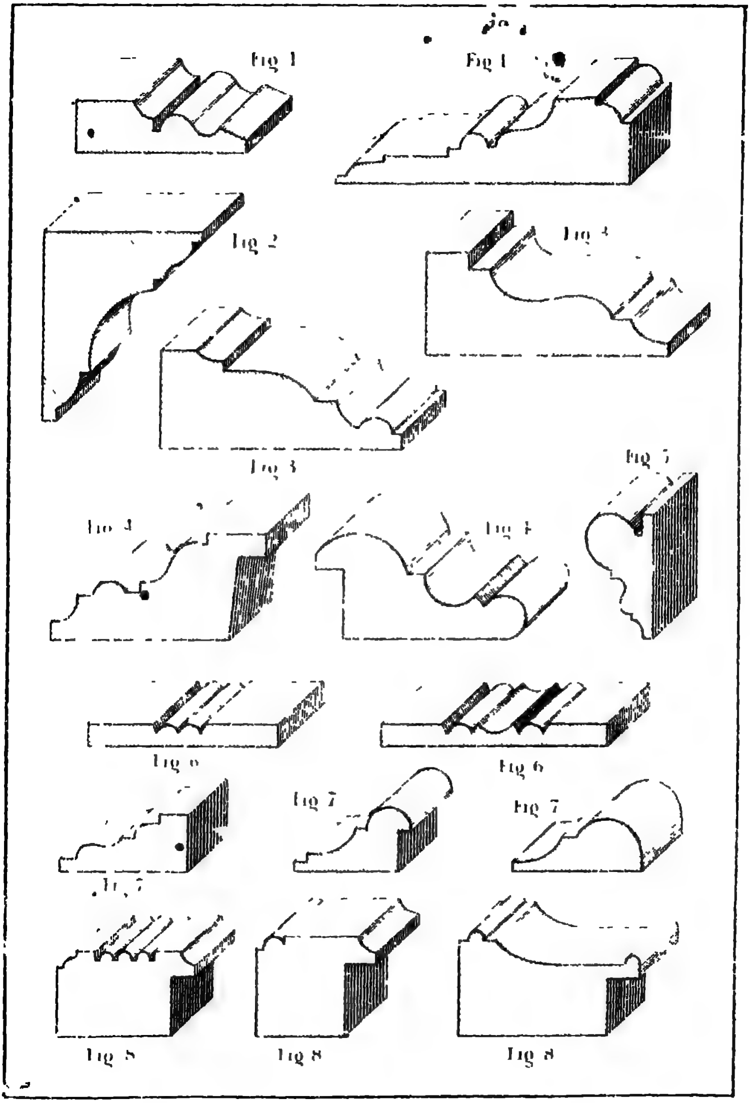
cutting blade and also to turn off the shavings in an upward direction through the mouth and escapement of the plane.

The **smoothing-plane** (Pl. I) is different from the jack-plane in shape, being about 8 in. long and 2½ in. broad in the widest part, where the iron projects from the wood, tapering to a width of about 2 in. in front and 1¾ in. behind, so that it may be more easily held in the hand. After the jack-plane has removed the rough surface from the sawn timber, the smoothing plane is used to make the surface perfectly smooth and even. The amateur artisan will do well to have a smoothing-plane fitted with an iron sole or plate extending over the bottom of the sole. The planes remain true much longer than the ordinary kind, although they are of course somewhat more expensive.

Trying-planes and **jointer-planes** (Pl. I) differ from the jack plane in being longer and set with a finer cut. The former are from 22 to 24 in., and the latter from 28 to 30 in. in length. The handles also differ in shape from that of the jack-plane as will be seen from the illustration, in which the toat or horn which forms the handle of the jack-plane and the looped handle of the trying and jointer planes are shown.

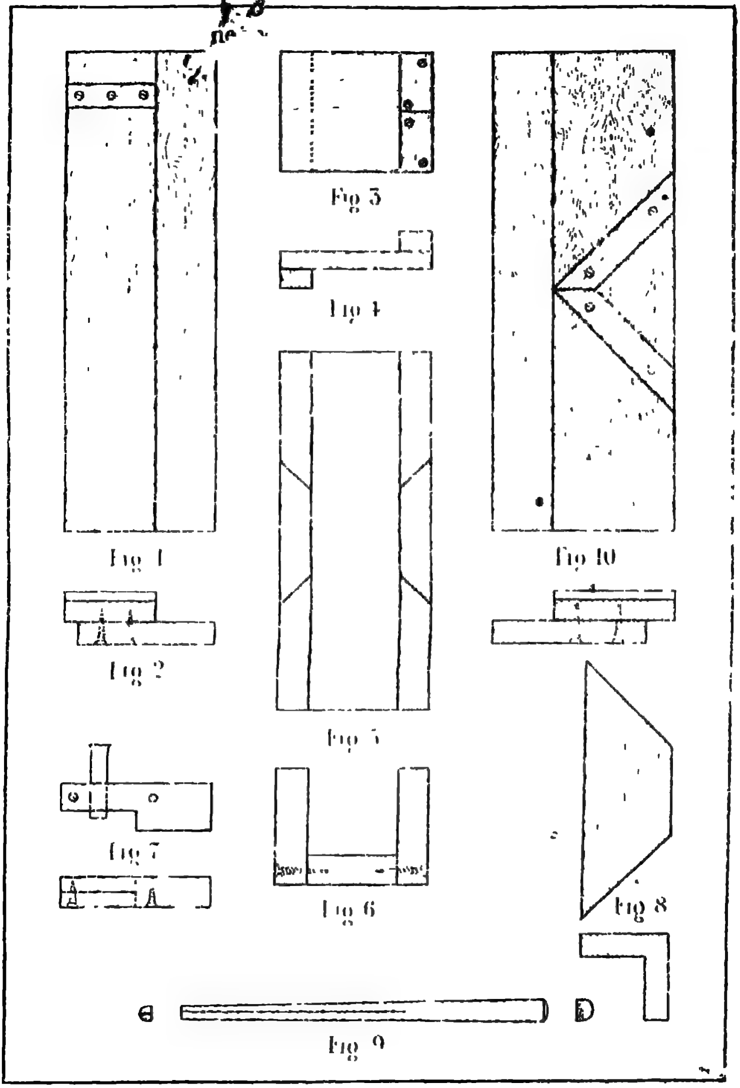
The great difficulty which is found by most amateurs in working with the plane is in adjusting the iron accurately so that the plane may cut properly and take off shavings of uniform thickness throughout. Again, it is necessary that the iron should project beyond the sole rather more for working some kinds of wood and rather less for others, although the actual difference may be scarcely appreciable. Facility in adjusting and using the ordinary plane can only be obtained by a certain amount of tuition from a skilled workman followed by plenty of practice. Of late years, however, some beautifully made planes have been brought into use in America and of these the amateur will do well to avail himself. The great merit of these planes is that they are self-adjusting, and this obviates most of the difficulty to which reference has been made. An illustration of one of these planes is given in Pl. VII. The cutting-iron is secured in position by means of an iron lever with a cam and thumb-latch at its upper end. A screw passing down into the iron bed-piece serves as a fulcrum on which the lever acts in clamping down the cutting-iron. The lever may be put in position or removed at pleasure without the use of any tool, as it is properly slotted for this purpose and the pressure required for the best working of the plane can be obtained at any time by tightening

Plate A. MOULDINGS.



(1) Architrave (2) Cornice (3) Panel (4) Bolection (5) Frieze or picture rail (6) Beadings (7) Cabinet (8) Picture frame

Plate B. WORK-BENCH ADJUNCTS AND ACCESSORIES.



1 and [illegible] Shooting board [illegible] and [illegible] Bench hook [illegible] and [illegible] Mitre [illegible] Home-made cutter [illegible] Mitre block [illegible] Home-made [illegible] Mitre shooting board

or slacking the central screw upon which the lever operates. The thumb-screw, located under the iron bed piece and just in front of the handle of the plane, works a simple device by means of which the plane-iron can be easily set forward or withdrawn while it is still clamped down to the bed piece and, without removing the hands from the plane or the plane from the work an adjustment for any desired thickness of shaving can be made with perfect accuracy. For beauty and style of finish these planes are unequalled and the great convenience in working renders them the cheapest planes in use. Each part, being interchangeable, can be replaced at a trifling cost

In the **rabbet** or **rebate-plane** (Pl. I) the iron projects slightly from the side as well as from the bottom of the plane. With this tool the edge of a board can be cut away so as to leave an indentation like a step all along its length to fit over and into a similar indentation cut in the edge of another board. The recess in a sash bar, into which a piece of glass is laid, is a rabbet or rebate.

There are many planes of different forms used for special purposes, as fillisters, sash fillisters, dado planes, compass planes, fluting planes, etc., but the description of them would take up too much space. They are, moreover, expensive and to purchase them would involve a far greater outlay than most amateurs would care to make.

Before proceeding with directions for the use of the various kinds of planes it may be well to emphasize the fact that care should be taken in all cases to see that the break-iron, or back-iron as it is sometimes called, is regulated according to the nature of the work to be done with the plane. Thus when the jack-plane is required for heavy work, such as for hacking down a rough and uneven surface, the edge of the break-iron should be about $\frac{1}{8}$ in. from the edge of the cutter, but for fine work there should not be more than $\frac{1}{16}$ in. space between the two edges. In the smoothing plane the edges of the two irons should be even closer than this - indeed, so slight as to be perceptible and nothing more The higher the break-iron, the easier the plane will be found to work and the lower it is the heavier the plane will work, although the cut will be cleaner.

To hold the jack-plane when in use, the handle must be grasped firmly with the right hand; the left hand is placed on top of the stock, in front of the iron, as shown in Pl III, Fig. 1, the thumb being on the side of the plane nearest the operator. Heavy pressure of the left hand in this position is necessary, in order to

keep the fore part of the plane well down so that the iron may take firm hold of the surface of the wood. During the first part of the cut, the pressure of the right hand on the back part of the plane should be somewhat relaxed, but when the cut is approaching completion, the pressure of the right hand should be increased and that of the left hand lessened. The amateur, unless he has a trying plane, will use his jack-plane for shooting the edges of boards. In performing this operation the plane is held in a different manner. The handle is grasped by the right hand as before, but the left hand is placed by the side of the plane nearest the operator, the thumb being on the upper surface, the fingers along the side and under part, forming a sort of gauge or stop to regulate the passage of the plane along the wood. The manner of holding either the jack-plane or trying-plane in shooting-boards is shown in Pl. III, Fig. 2. The method shown in Fig. 1, is that adopted in planing the *surface* of the board or, in technical language, "facing up."

The method to be followed in holding the American iron plane is the same as that described in the case of the wooden plane with some slight modifications necessitated by the difference of construction. By following the general instructions given above, however, the operator cannot fail to handle the American plane as easily as the old-fashioned wooden one.

The **smoothing plane,** as already indicated, is used for cleaning off and reducing to smoothness and a perfect level, the surface from which the rough exterior has already been taken by the jack-plane. The distance between the edge of the cutter and that of the break-iron should not, in the case of the smoothing plane, exceed $\frac{1}{20}$ in., and may be even less with advantage. The plane has no handle, and must be held as shown in Pl. III, Fig. 5; the right hand being placed over the stock of the tool, grasping it firmly, just behind the iron and wedge, and the left hand on the forepart of the side next the operator, the fingers being turned over the front and the thumb on the top, the forepart of the plane being thus completely covered by the hand. The strokes or cuts made with the smoothing plane are short and quick, and sometimes a motion that may be described as curvilinear, or having a slight circular sweep, is given to the plane.

There are other points, in addition to holding the plane, that require attention, and these are the direction in which boards or other pieces of wood are to be planed, the manner in which the plane-iron is to be taken out of the stock, when necessary, for

sharpening and the regulation of its projection beyond the sole or under surface of the stock.

The wood to be planed should be laid flat in the bench with one end abutting on the wood stop, which is fixed in the bench in such a manner that it can be raised or lowered at pleasure, according to the thickness of the wood to be planed. In order to obtain a perfectly smooth surface, all planing must be done in the direction of the grain of the wood. If an attempt were made to plane the wood against the grain, the cutting edge of the plane would strike against the projecting edge of each successive layer of fibres, and if the wood were soft as in fir, and the edge of the cutter were not very keen, it would bend them back, and here and there the surface would be broken by a rough ridge. Where, as is sometimes the case, the grain in different parts of the wood runs in contrary directions, the difficulty is met by planing the wood first in one direction and then in the other, to suit the grain. No fixed rule can be laid down, but the operator will very soon find from the behaviour of the tool he is using, in which direction it ought to be worked. In planing wood rough from the saw, the plane should at first be worked in the direction of the saw-cut, the rough particles being bent in one direction by the action of the teeth and sides of the saw. When the true grain of the wood has been revealed, the planing should be done in accordance with the directions given above.

To remove the plane-iron and the wedge by which it is held in place, the amateur artisan, unless he has been instructed in the proper method of performing this operation, will in all probability try to accomplish it by knocking the wedge and iron first on one side and then on the other with a hammer. Such a course will spoil the plane. To loosen a plane-iron in order to remove it for sharpening, etc., hold the stock of the plane in the left hand and with a hammer or mallet held in the right hand, strike the stock lightly and quickly on its heel or back (Pl. XVII). This will loosen the iron sufficiently to admit of its removal with the thumb and finger. In like manner, when it is desired to tighten the wedge which holds the iron or to make the edge of the cutter project a little more beyond the surface of the sole of the plane, all that is necessary is to strike the stock on the front in a manner precisely similar to that adopted for loosening the iron by striking the heel of the plane. Neither the wedge nor the plane-iron should, as a rule, be struck on the top, though occasionally the slightest possible tap may be given to the wedge in order to drive it in a little further, or the iron

may be tapped as lightly as possible in order to secure its proper adjustment in bringing the edge parallel with the surface of the sole. The sole of the plane, if the stock be without an iron plate or shoe, should be greased or oiled occasionally. This has the effect of preserving the stock and causing it to move more easily over the surface of the wood which is being planed.

Much of the difficulty which amateurs experience in using the plane arises from the cutting-iron being *badly set for work.* If either corner projects beyond the level of the sole of the plane, this will necessarily score grooves or channels. Hence, in sharpening the tool, the extreme angle should be slightly rounded off. The same bad effect will be produced if the plane-iron is not ground truly square. The smaller, or break-iron, which serves to break up the shaving sharply so as to ensure the cutting of the other iron and to prevent its splitting off the surface of the work, should be placed so as to come within $\frac{1}{8}$ in. of the extreme edge of the cutter for rough work, and within $\frac{1}{20}$ in. for finer or finishing work. The two should then be placed in position so that the edge projects the smallest possible degree below the sole. The position can only be determined by looking carefully along the bottom of the plane with the front of the same next to the eye, as in Pl. XVII. The edge will, if correctly formed and placed, appear quite parallel with the sole. It is then ready for use. The same rule applies to the small and to the large planes, except that in the jack plane the iron projects somewhat more, as it is used for roughing down a surface. The trying-plane, which is longer, and intended for edging boards which are to be jointed lengthwise, is like the smoothing-plane, always very finely set. The break-iron is also set very close down to the cutting edge. The longer the plane, the more level and true will be the work done by it. As it will be useless for the amateur to attempt the construction of any work, except of the roughest character, until he can plane a board accurately on both sides and keep the edges square and sharp the greatest attention should be given to the use of the tool.

It has been said that the planes which the amateur artisan most requires are the jack-plane and the smoothing-plane. With these he can do all ordinary work, but for rebating, grooving and tonguing, and operations of a similar character he requires planes of a different construction, such as the rebate-plane, match-plane and plough. The principle and general construction of the most important tool in this group, the rebate-plane,

have already been described. It is only with the mode of using it that we are therefore now concerned.

For rebating, or cutting a rabbet along the edge of a board, that is to say, taking away a portion of the upper edge rectangular in section, so that the lower edge projects beyond the upper part of the board like one step below another, a rebate-plane is required. Indeed, it is desirable to have two of these planes, one having the iron set across the sole at right angles to the length of the plane for cutting a rebate parallel to, or *with*, the grain, and the other with the iron set obliquely across the sole for cutting a rebate at the end of a board *across* the grain. To work such planes as these with anything approaching accuracy, or, in other words, to make a rebate parallel to the edge of the board, is a difficulty which is experienced by regular artisans as well as by amateurs. For this reason, it is usual in operations of this kind to use a plane known as the side fillister or filletster. This plane has a shifting fence at the bottom secured by two screws which work in slots so that its position may be regulated in accordance with the width of rebate to be made. A screw-stop is also placed on the side of the plane farthest from the operator, by means of which the depth to which the cutting iron may enter the wood and clear it away is regulated, and in front of the grooving-iron there is an iron which projects slightly below it. This cuts down the vertical side of the rabbet, while the plane-iron carries away the wood horizontally, so that with the combination of cutters it is impossible for any wood to be left in the angle of the rebate. The rebate-plane and the side fillister is generally held with the right hand on the top of the stock behind the iron, and the left hand on the front (Pl. IV). The side fillister is by no means an expensive tool, but if an amateur has a rebateplane he can easily furnish it with an attachment which will render it quite as useful as any side fillister he might purchase. Supposing that on the edge of a board it is required to cut a rebate ½ in. wide and ¼ in. deep. A strip of these dimensions has literally to be planed away, and the plane must therefore be prevented from travelling horizontally on the board further than ½ in. and vertically it must not be allowed to sink deeper than ¼ in. Rebate planes are made from ¾ in. to 2 in. wide. We will assume that the one with which the work is to be done is 1½ in. wide. Plane up a strip of wood, to the width of 1 in. (the thickness is not of importance), and screw it at right angles to another piece so as to form a letter L. This will form a case which will, when planed and fastened

to the side of the plane with a couple of screws, shut off 1 in. of the width of the sole, allowing it to encroach upon the surface of the board to the extent of ½ in. only. A mere strip, screwed on the other side at ½ in. from the sole, will prevent the plane sinking deeper than is required. It is not necessary to damage the sides of the plane by making more than two screw-holes, as the same side-piece of the case may be permanently used, the width of the bottom strip being altered according to circumstances. The width of side slip can also be regulated either by planing a portion off below the screws if the rebate is to be deeper, or moving the screws lower down in the strip if it is to be shallower, taking care that the holes correspond with those in the side of the plane, and that the strips do not cover the aperture through which the shavings should escape.

One of the most desirable planes with which an amateur may provide himself with after the jack-plane, smoothing-plane and rebate-plane, is a **chamfer-plane,** for this is frequently brought into requisition, even in ordinary carpentry and joinery, and particularly in frame-making. The body of the plane may be described as a kind of box which is closed behind and open in front, except across the bottom, where a metal plate of no great width is screwed to the sides. One of the sides is lower than the other. This side is bevelled at an angle of 45°, and forms part of the fence or guide necessary to fit against and glide along the arris, or adjacent sides of the piece of wood to be stop-chamfered. The other and shorter side is perfectly level along its base, and made wider than the other in order to admit of the attachment of a piece of wood also bevelled on one side at an angle of 45°, which forms the other side of the fence. This piece is attached to the bottom of the left side of the plane by two clamping screws working in two parallel slots cut in the fence at right angles to its length. By this arrangement, the plane is rendered adjustable and chamfers can be cut of any width within the limits of the distance to which the movable fence can be removed from the fixed one. The plane itself is of the bull-nosed pattern. When using the stop-chamfer-plane it will be found that the cutting iron gets very near to the end of the work, the portion remaining untouched by it between the end of the planed surface and the stop being no more than the thickness of the piece of metal screwed on in front of the plane.

To those who may require such a plane, and may yet be unwilling to incur the expenditure for a tool having only a

special purpose, it will be useful to know of a method by which an ordinary smoothing-plane can be quickly converted into a stop-chamfer-plane and, after being used as such, speedily reconverted into a smoothing-plane. For this purpose, two pieces of hard wood should be obtained—beech is the best—each half the width of the smoothing-plane at its widest part, the same length as the plane and ½ in. thick. One edge of each of these should be planed off lengthways to an exact angle of 45°. These pieces of wood, which are to act as a fence or guide, should then be fixed with two screws in each to the sole of the plane and a V-shaped groove about ⅛ in. deep should be cut across, both of them on the faces next to the plane so as to well clear the edge of the plane-iron. One of these guides should be screwed fast with its chamfered edge truly down the centre of the plane. The other is to be made to shift inwards or outwards by having slots for the screws instead of round holes. The width of the slots should be equal to the diameter of the screws, and the length, say, ⅝ in., plus the diameter of the screws. If chamfers wider than ⅝ in. on the face are likely to be required, the slots must be longer in proportion. By slacking the screws of the shifting piece it can thus be adjusted with its chamfered edge at any distance within its limits from the edge of the fixed piece, and this distance will equal the width of the face of the resulting chamfer. A scale in sixteenths of an inch marked on the bottom edges of the ends of the plane will facilitate the adjustment for any desired width of chamfer. When it is desired to again use the tool as a smoothing-plane, the hard-wood pieces may be unscrewed and put away until required again. The four screw-holes in the sole of the plane will be no drawback provided that they have been carefully made without projecting edges. To ensure this, the entrance should be cleared with a sharp boring bit and, if necessary, rubbed lightly with smooth glass-paper.

Contrivances of the kind just described are so handy and useful to the amateur that it may not be undesirable to give a further instance in which the application of a guide or fence to a plane will render the work perfectly square and true, even if done by an unskilled workman. In this case it consists of a side guide for a trying-plane, the guide consisting merely of a piece of wood about 4 ins. wide and ¾ in. thick attached to the side of the plane This piece of board is screwed to the side of the plane, the upper part being slightly rebated on the inner side so as to permit the left-hand edge of the plane to rest

on the shoulder thus formed. The pressure of the guide against the side of the piece of wood which is being planed keeps the plane-iron perfectly square, and if the iron has been accurately set, a perfectly square edge will be the result.

Match planes are bought in pairs, one of the two being so made that the iron cuts a groove or trench lengthwise in the edge of a board, and the other so that the iron cuts away the edge on both sides, leaving a projecting rib or tongue in the centre which, when the boards are brought edge to edge, fits tightly into the groove which has been cut by the other plane. Match planes are so called because the width of the projection left by one plane matches, or corresponds exactly with the width of the groove left by the other. As already pointed out, however, the amateur can always buy matchboarding ready for use, and can therefore very well do without these planes.

The **plough** (Pl. VII) is used for cutting grooves in wood at any distance from the edge, provided that this distance be not greater than the strips or bars of wood attached to the fence by which it is guided in a direction parallel to the side of the wood. It is held, as shown in Pl. IV, by putting the right hand over the top of the plane behind the iron, the first finger along the top by the side of the iron, and the other fingers round the arm. The left hand holds the fence at the side, the thumb on the top of the arm, the first finger extending along the fence and the remaining fingers closed. The plough is necessary in such work as making drawers in which the bottom is let into a groove made all round the inner surface of the sides at a short distance from the lower edge. It is fitted with eight irons ranging in width from $\frac{1}{8}$ in. to $\frac{5}{8}$ in. for making grooves of various sizes. The depth to which it is desired that the iron should go is regulated by a top screw attached to the plane.

Paring tools which may be regarded as being allied to the plane are the **spoke-shave** and the **drawing-knife.** The spoke-shave is, in fact, a form of plane used for modelling curved surfaces and edges. In the form commonly used in England (Pl. VII) it has a wooden stock, generally of beech or box-wood, the ends of which are shaped as handles. The blade is narrow and comparatively thick, is slightly curved and has a keen knife-like edge. At each end is a square spike or tang bent at right angles to the flade. These spikes pass through the holes in the stock, and retain the blade securely in position parallel to the length of the tool. The space between the sole and the blade may be

regulated by lightly tapping the end of each tang, so as to drive the blade farther from the sole. The American form of spoke-shave (Pl. VIII) has an iron stock, and is fitted with a screw by means of which the blade can be adjusted to a nicety. In a recently introduced pattern described by the makers as a "universal" spoke-shave, both handles are detachable, so that the cutter may be made to work into corners or panels. This tool has two detachable soles, adapting it equally well to straight or circular work, and by means of a movable width gauge, it can be used in rebating. The manner of holding the spoke-shave is shown in Pl. V.

The spoke-shave form has been adopted recently for many kinds of cutting and scraping tools. The iron chamfer shave, one of the best of its kind, consists of four parts, viz., the stock, the cutting-iron and two fences which are adjustable from $\frac{1}{8}$ in. to $1\frac{1}{8}$ in., so as to cut any width chamfer which is likely to be required in ordinary work. The stock, which is of iron, is pierced at either end in order to reduce its weight. Between the perforations runs a groove in which the fences slide, being loosened or tightened by the screws which enter the stock. The cutting-iron is inserted in a groove cut to receive it in front of the stock. The extent of the edge exposed is regulated by a screw which works through a slot in the cutting-iron.

The **draw-knife**, or **drawing-knife** is simply a long blade, perfectly rigid, with a spike at each end fitted into a wooden handle. It is useful for reducing the size of any piece of wood which it may be inconvenient to cut down in the ordinary way, and when some degree of force is applied it does its work quickly and effectually. It is used in one direction only, with the edge of the blade towards the worker. It can only be applied to straight work and not, as in the case of the spoke-shave, to circular work. The chief points of difference between the two tools are that in the draw-knife the blade itself is straight and not curved, and that the tangs instead of being at right angles to the back of the blade, are in the same plane as that in which the blade itself lies. The general form of the draw-knife is shown in Pl. I, and the manner of using the tool in Pl. V.

The **chisel** is a flat and thick piece of steel, of which the cutting edge is ground to a bevel having a very acute angle, while the other end is fashioned into a tang with a projecting shoulder which fits close against the wooden handle into which the tang is inserted. There are different kinds of chisels, but those with

which the amateur woodworker should furnish himself are firmer chisels and mortising chisels. The *firmer chisel* is that most ordinarily used by carpenters, and is the kind which will be most required. The only difference between firmer chisels and paring chisels is that the former are somewhat shorter and thicker in the blade. The latter are chiefly used by pattern makers for finer and more delicate work.

Firmer chisels are of various sizes, from $\frac{1}{8}$ in. width in the blade to 2 in. About half a dozen chisels are the utmost number which the amateur will require. The sizes which he is recommended to obtain are $\frac{1}{8}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., $1\frac{1}{4}$ in. and $1\frac{1}{2}$ in. The ordinary carpenter's or firmer chisels should be purchased in the first instance. A few paring chisels can be added to the stock at any time if required.

Mortise chisels are used for cutting mortises or slots through the thickness of a piece of wood, and as they are subjected when in use to heavy blows with the mallet, they are made much thicker in the body than are ordinary chisels. While the latter are contracted in width between the broad, flat blade and the shoulder, mortise chisels are broadest at the shoulder and narrow gradually until the bevel is reached. This is done in order to impart extra strength to the tool. Examples of mortise chisel are given in Fig. Pls. VII and VIII. They are made in eight sizes, ranging from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in. The old-fashioned form has a strong broad, disc-shaped shoulder which butts against a very strong, though coarsely fashioned, wooden handle. It is perhaps still the best chisel for narrow mortises. In a comparatively new pattern, the blade contracts in width before reaching the shoulder after the manner of the firmer chisel, but the blade is much thicker and stronger than in its prototype. The defect of these chisels is that they have not enough wood projecting beyond the ferrule at the end of the handle. In time, this end is beaten down and the edge of the ferrule then causes indentations on the face of the mallet.

The **gouge** differs from the chisel only in being hollow instead of flat. Gouges are made in sizes varying from $\frac{1}{8}$ in. to 2 in. The ordinary firmer gouge (Pl. VI) is ground on the convex surface; what is known as the sash or scribing gouge, a tool with a somewhat thinner blade, is ground on the inside. Turning gouges are much longer than firmer gouges. They are used for roughing down work in the lathe. These, together with turning chisels, will be dealt with more fully in the chapter on Turning.

A cold chisel is a strong piece of steel, bevelled on both sides at one end to a blunt edge, and is occasionally used by carpenters to knock out a hole in a wall of stone or brick for the insertion of a wooden plug, the end of a piece of timber, etc.

It is obvious that the modes of using chisels and gouges of the ordinary form cannot be many. The uses of the chisel are restricted to paring and cutting mortises; the gouge is used chiefly for making grooves, scooping out hollows or in cutting mortises when the tenon is rounded instead of being perfectly square.

In paring with the chisel in such an operation as clearing out the waste wood from a groove of which the sides have been cut down with a tenon-saw, the butt of the chisel should press against the fleshy portion of the right palm with the fingers holding it firmly, as in Pl. VI, Fig. 2. The left hand should be used to hold the chisel down and to guide it. When the end of a piece of wood is being cut perpendicularly, or very nearly so, across the grain, the tool should be grasped firmly in the right hand, as shown in Fig. 3, the piece of wood which is being cut being held down by the left hand, which must in all cases be placed *behind* the chisel, well out of the way, so as to avoid injury from any slipping of the tool. A still more important warning is that in no case should the head be bent over the work when the chisel is being used. There is a great temptation to watch closely when the tool is getting near to the line marked by the gauge. A knot or patch of cross-grain will sometimes cause the chisel to slip and be jerked upwards, with risk of serious injury to the face. By observing the simple precautions given above, however, all danger of injury to the eye or face is obviated. When paring in the direction of the grain, as in cutting a point to a piece of wood or in fashioning a wedge, for example, the chisel and the wood should be held in the position and manner shown in Fig. 1.

The gouge may be held in the manner indicated in Figs. 2 and 5, according to the nature of the work which is being done. Thus, in cutting a groove across the grain in the end of a piece of wood, it should be held as in Fig. 2, or in scooping out the hull of a model boat it should be held as in Fig. 5. In this way the gouge is sometimes used to prepare a shallow cavity for the entrance of a shell auger or shell-bit when used in the brace.

In cutting a mortise, the chisel is grasped firmly by the left hand and held in a nearly upright position, as in Fig. 4. The

wood is in all cases cut by the chisel across the grain, and the operator must take care to remember that the flat part of the chisel must always be turned towards the end of the mortise. Thus, in cutting a mortise, the position of the chisel must be continually changed, the bevel being towards or turned from the worker according to circumstances. The chisel is struck with a mallet held in the right hand. It will be found that there is no necessity to make any cut with the chisel in the direction of the grain. All that need be done is to continue to make cuts at a short distance from each other across the grain, beginning in the middle of the wood to be removed, and working towards the end of the mortise.

Scrapers, so called, are thin pieces of steel plate used by cabinet-makers to dress, or finish off, the surface of wood after it has been rendered as smooth as possible by the ordinary process of planing. They are made in various shapes. The ordinary rectangular scrapers are from 4 to 6 in. in length, and from about 2½ in. to 3½ in. wide. A genuine cutting edge is given to the steel by compressing the flat edge and bending it over so as to slightly project beyond the flat surface. This projecting edge, though invisible to the unaided eye, should be such as to be distinctly felt when the tips of the fingers are slid across the surface of the metal in a direction from the centre. The method of producing it is described in the chapter on sharpening tools (see p. 160). When in good order, the tool should pare off shavings of perfectly uniform thickness, though much finer than those removed by the most accurately set smoothing-plane. The scraper, when in use, should be inclined in a forward direction, so that when pushed away from the operator the cutting edge may properly cut the surface of the wood (Pl. XXVI). The exact inclination will depend upon the angle which the edge forms with the surface of the tool, but a very little practice will enable the amateur to know when a clean cut is being made and when the action is merely that of abrading or scraping away the material upon which he is working. In practice it will be found to be an advantage if, by pressing the thumbs against the blade, it can be slightly sprung or curved. A form of holder has been recently introduced from America, in which such a curve is obtained by means of a thumbscrew acting on the centre of the steel.

Boring Tools.—The tools comprised in the first division of *boring tools* are bradawls, gimlets and augers. These tools are for the most part extremely simple in construction, the bradawl

being a piece of steel sharpened at the end and fixed for convenience of use in a wooden handle, and the gimlet a piece of steel so fashioned that it may screw and cut its way into wood and having a small cross piece at the end to serve as a handle for turning it. The auger is merely a gimlet on a large scale, the cross handle being turned by the operator with both hands, which are transferred from end to end of the handle at every half turn of the tool. The gimlet is held and turned with the right hand only.

The **bradawl** varies in size or diameter of the steel shaft from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. or $\frac{3}{16}$ in. Smaller sizes are made, but these are generally called sprig tools, the term bradawl being more strictly applied to the larger sizes only. The piece of steel forming the bradawl is fitted with a shoulder and tang which is inserted into a handle, generally of beech or ash. The shoulder abuts against the handle, as in the case of the chisel and gouge and to keep the handle, from splitting when the tang is driven into it, it is furnished with a narrow brass ring or ferrule. The end of the steel shaft thus handled is ground down on either side so as to form a Λ-shape. Either side of the shaft, when ground, presents the appearance shown in Pl. X, Fig. 1.

In the case of the ordinary form of bradawl, it sometimes happens that the strain of constant use will cause the awl to work loose in the handle, and when an attempt is made to withdraw it from the wood into which it has entered, the handle comes away in the hand of the operator, leaving the steel in the wood. This is prevented, however, in the Patent Brass-capped Bradawl shown in Pl. VIII, the awl being securely retained in the handle by a brass cap which fits over and is fastened to the end of the handle.

Another useful form of bradawl which is likely to commend itself to amateurs who wish to have their tools in the smallest possible compass is what is known as the combination set (Pl. VII). The handle is supplied with twelve awls in a tin box. Each awl, whether large or small, has a square shank which fits into the iron heading, or cap, of the handle, the end of the shank being visible, as shown in the illustration.

In boring a hole with the bradawl care should be taken that the straight edge of the tool is first placed across the grain of the wood as shown in Pl. X, Fig. 1 and not parallel to it. When the tool is being forced into the wood, it should not be turned completely round, but should be given only sufficient movement to right and left alternately to cut and crush the

fibres and so pierce the material. In this way the risk of splitting the wood is much lessened.

The legitimate purpose of the bradawl is to bore holes in wood so as to ensure the passage of a nail or screw in the right direction, and also to facilitate its entrance into the wood; but occasionally for driving in or withdrawing small screws a large bradawl may be conveniently used as a screw-driver.

Gimlets (Pl. VIII) are commonly of two kinds, plain or shell and twisted. The plain gimlet has a steel shank with a small screw point and a straight groove running more than halfway up its length. It is more apt to break or twist in hard wood than the spiral or twisted gimlet, and when it is used for boring a deep hole the friction arising from the portion of wood cut away becoming tightly packed within the groove renders the tool somewhat difficult to work. The twisted kind possesses two advantages over the plain gimlet: it can be worked with more ease, as the wood which is cut away is forced up the spiral groove and automatically cleared as the tool penetrates the wood, and the hole made is cleaner.

What may be regarded as a combination of the shell and the twisted gimlets is found in the Swiss, or half-twist variety. It is claimed for them that they enter the wood more easily than the ordinary shell or twist gimlets, and are less liable than these to split the wood.

The **auger gimlet** is merely a gimlet on a large scale. They range in size from ¼ in. to ½ in. in diameter. Auger gimlets are useful for boring large and deep holes for the passage of screw-bolts, etc.

Gimlets may be obtained cheaply in sets. The shanks in these sets are so fashioned that the bits may be used either with the ordinary gimlet handle or in the brace. The additional turning power of the brace will be found very convenient when it is desired to bore a large number of holes, or when working upon hard wood.

The handle of the gimlet consists of a piece of box-wood usually turned in the form shown in the illustrations. The steel is squared at the upper end and tapers away to a fine point. This part keys into the handle, and the end is riveted over a copper disc or washer. In this way the shaft is prevented from slipping round in the handle when pressure is used to turn it. The amateur will find three or four gimlets of various sizes as many as he will require. In using the gimlet the cross-piece or

crutch-handle is grasped in the right hand and held against the palm, the shaft of the tool projecting between the first and second fingers as shewn in Pl. X, Fig. 3. It is driven into the wood by a series of half-turns of the hand from left to right, the handle being released and grasped again at every half-turn.

Brace and Bits.—The pattern of brace recommended for the use of the amateur artisan is shown in Pl. VIII. The socket at one end of the brace is fitted on with a screw thread. When screwed down it allows the steel jaws to open and the shank of the bit may then be inserted. When screwed up, the jaws tighten and firmly grip the object placed between them. In this way the brace will hold bits, reamers, counter-sinks, etc., of various shapes and sizes, and hold them true. The convenience of this will be realized when it is remembered that the old-fashioned brace will receive only such shanks of bits as are made to fit the box or socket. This often necessitates a considerable amount of filing and fitting of the shank before the tool can be used in a particular brace; in other cases, the shank is too small and, fitting loosely, is practically useless. The brace shown in the illustration is fitted with ratchet, by means of which it can be used for boring in positions such as corners or near to walls, where it is possible to give only a half-turn to the handle.

The bits used in the brace are many in number and adapted for widely different purposes. Some of the forms in use are shown in Pl. IX. The most common form of bit is known as the centre bit, on account of the prolongation of its end into a long, sharp point which marks the centre of the circular piece of wood which it removes in cutting a hole. Bits of this form are made of all sizes to cut from $\frac{3}{8}$ in. to $1\frac{1}{2}$ in. in diameter. When the point has been forced into the wood at the centre of the circle which marks the outline of the hole to be cut, the tool is caused to revolve rapidly by turning the crank of a brace; a sharp edge cuts the wood vertically as the tool enters, and another cutting edge which extends from the central spike to the outer part of the bit, shears out the waste wood. Among other forms of bits shown in the illustration are the taper bit, which is used for boring a tapered hole, the shell-bit, something like a plain gimlet but with a broad scooped edge at the end instead of a screw, and a bit of solid make known as the rose-bit or rose-headed countersink. Rose-bits and countersinks are necessary when it is desired to let in the conical head of a screw flush with or below the surface. The roso-bit will

be found especially useful for such work as deepening the holes of a hinge. A complete set of bits numbers about thirty-six tools, but the amateur will probably prefer to purchase them separately as he requires them. The smaller ones cost somewhat less than the large ones. Black bits are somewhat cheaper than the bright kind, and are less liable to rust.

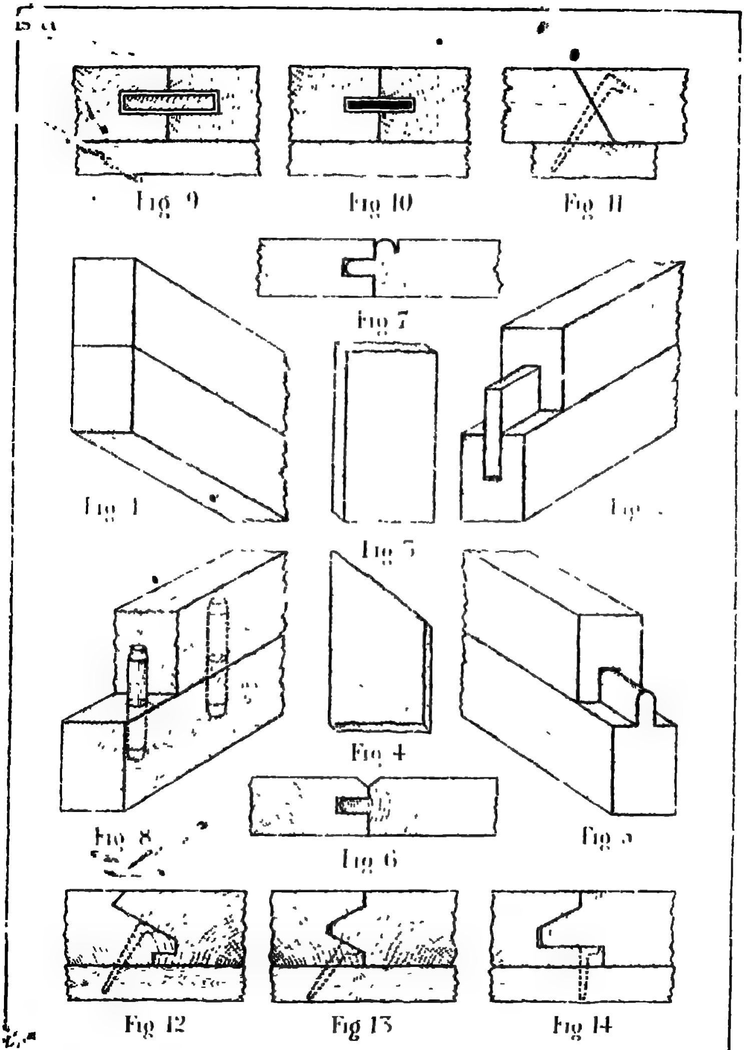
A good boring bit which may be adapted to perform the work of a number of separate centre-bits is the Expanding Bit shown in Pl. VIII. It is made in two sizes, each size with two cutters, small size, ½ in. to ⅞ in., and ⅞ in. to 1½ in., and large size ⅞ in. to 1¾ in., and 1¾ in. to 3 in. This is found to be a useful tool when it is desired to cut holes of diameters *between* those of each pair in the series of separate centre-bits.

In recent years there has been introduced an excellent class of bits known as screw-bits. These are shown in the illustrations (Pls. IX and X). They cut a very clean hole either with or across the grain of the wood.

When boring a series of holes of the same depth throughout, it is useful to have some means of automatically checking the progress of the boring tool. This is to be found in the bit gauge, of which an illustration is given in Pl. VIII. It is claimed for this gauge that it may be used on polished surfaces without leaving marks.

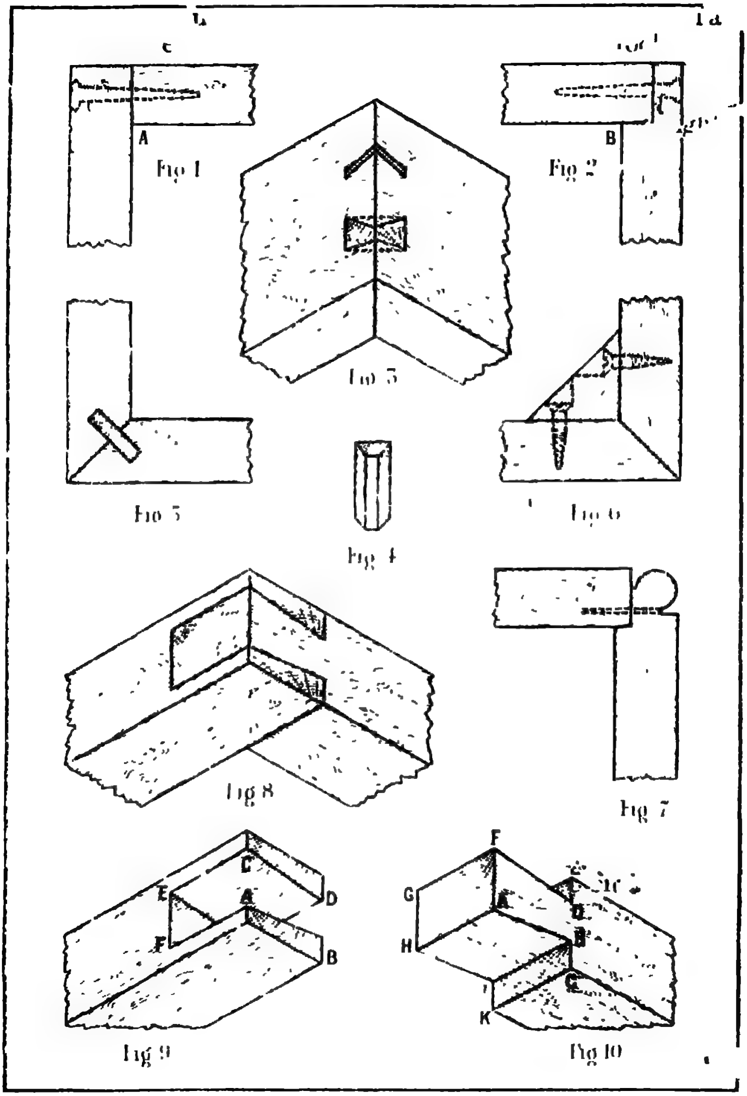
Attention may also be drawn to a very useful bit called the Forstner Bit (Pl. VIII). It is made in sizes ranging from ¼ in. to 2 in. in diameter. Unlike other bits, it is guided by its circular rim instead of the centre, and, consequently, will bore any arc of a circle and can be guided in any direction regardless of grain or knots, leaving a smooth surface. It will be found very convenient for work on core boxes, fine patterns or veneers. This bit is especially serviceable in cases where it is desired that the hole should terminate at the bottom in an even, unbroken surface, which cannot be effected when the centre-bit or twist-bit is used. The shank of the bit is terminated in all sizes by a shallow, circular cup, within which are two cutters, so disposed that each cutting edge is parallel to the other. These cutters have their edges on a level with the lower edge of the circlet of steel which contains them and incline in opposite directions, until they reach the upper edge, from which, indeed, they proceed. A [illegible] is made in the side and top of the circlet, and this affords a means of clearance of the fragments cut away by the edges. As there is no screw on the bit, it is, of course, liable to jam in a deep hole unless it is taken out and cleaned, but the great advantage

Plate C. EDGE JOINTS.



1 Square or plain glued joint [illegible] Ploughed and tongued joint [illegible] and [illegible] Tongue [illegible] Matched joint [illegible] and [illegible] Match boarding joints [illegible] Dowelled joint [illegible] and [illegible] Ploughed and tongued dry joints [illegible] Flooring joints

Plate D. ANGLE JOINTS.



1. Butt or square joint, [illegible] and [illegible], Rebated joint, [illegible] 3 [illegible] and 5, Keying. 6, Corner piecing, [illegible] 8, 9 and 10, Simple Dove-tail joint.

is that it will cut at almost any angle and enlarge a hole already made. For special directions as to sharpening the Forstner bit, see p. 107.

For boring through very hard wood there is nothing better than the Morse brace drills used by metal workers. They will bore a smooth hole in any direction, and will not split the wood or turn aside from the grain or knots. They may be obtained in any size from $\frac{1}{16}$ in. to 1 in.

For use with drills of the last mentioned kind, the amateur would be well advised to procure a hand-drill (Pl. VIII). This drill is double-geared, and is provided with a wide rim gear to be grasped between the thumb and finger when the drill is used for delicate work. In this way it can be used without the liability of breaking the points.

Another useful form of drill stock is a variation of the archimedean form, and is known as the reciprocating automatic drill. It may be used with either the plain or Morse twist drills for wood, brass or iron, and will be found very useful for drilling holes where braces, breast drills, or hand-drills cannot conveniently be brought into play. The three-jawed chuck with which it is generally fitted has a capacity of $\frac{1}{4}$ in., and the tool is nicely finished and well constructed throughout.

The uses of the brace and bits have been fully explained. The brace may be held in any position, and a skilled craftsman will do so and manage to bore a hole truly perpendicular to the surface with the greatest facility. The amateur, however, will do well to stand upright, or as nearly so as possible, when using the brace and bit, having the part of the wood in which the hole is to be bored about the height of his chest or a little lower. The brace and bit may often be used with advantage when cutting a mortise, and a shell auger may also be used for this purpose. A bit or auger of the width of the mortise should be used, and the work of the chisel is then confined to cutting out the corners and the projections between the holes.

In boring a hole with the brace and bit the head of the tool is generally placed against the chest or stomach, against which it is pressed firmly by the left hand, which grasps the tool directly in front of the knob, the fingers resting on the part which is uppermost. The handle attached to the crank or sweep is grasped with the right hand, as shown in the illustration (Pl. X, Fig. 5), and the bit is caused to revolve in the direction followed by the hands of a clock. The manner of using the brace when boring vertically is shown in Pl. X, Fig. 4. It requires a good

deal of practice to use this serviceable tool with ease and readiness, but when the amateur has overcome the first difficulty of managing it, he will find it to be of the greatest assistance in carrying out many operations in carpentry and joinery.

Holding or Grasping Tools may be regarded as falling into three groups: (1) the simple tools of this description used for pulling out nails, holding and bending wire, etc., and comprising all kinds of pincers, pliers, spanners and wrenches; (2) nippers for cutting as well as grasping, and (3) vices of all kinds, including bench and hand vices, clamps and holdfasts.

The amateur artisan should provide himself with a small and a large pair of pincers of the best kind. The illustration in Pl. VIII represents the form known as Lancashire pincers. These are made in various sizes ranging generally from 5 in. to 9 in. in length. The most convenient sizes are 5 in. and 8 in. Common pincers are apt to get indented along the edges of the jaws and so lose much of their grasping power. The construction of these is so apparent from the illustration that any detailed description is unnecessary. In the cutting nippers the holding or flat part of the jaws extends about halfway down from the end, and the jaws are then cut away so as to form a sharp wedge-shaped blade which is well adapted for cutting wire. These will be found useful in many ways, but more especially in wire working. In what are termed round-nosed pliers, the jaws instead of being flattened for gripping small nails, wire, etc., are rounded from base to tip so as to form small truncated cones. These are used for turning the end of a piece of wire so as to form a loop, the size of the loop depends on the position in which the wire is held on the tapered nose.

The amateur artisan will sometimes find it convenient to utilize egg-boxes and packing cases of various descriptions which may be obtained from local tradesmen at nominal prices. A good deal of wood which can be used for a variety of purposes can be got out of these cases, though generally the worker will spoil half the boards in knocking or wrenching them apart with such implements as a hammer and a screw-driver or chisel. A very useful tool, known as a nail-puller, by means of which the case may be taken to pieces without injury to either nails or wood, is shown in Pl. VII. The following directions are given for using it: "With the left hand grasping the instrument as low as convenient, place the jaws astride the nail in the wood with the foot-lever parallel with the grain of the wood, and draw

the top of the tool towards you till the jaws come close up beside the nail. Then lift the rammer with the right hand and plunge it down sharply. This operation embeds the jaws under the head of the nail. A horizontal pull will then bring the nail out." The amateur who uses up plenty of packing cases for rough-fencing, sheds, fowl-houses, etc., will soon save the cost of this tool in boards which are not split or damaged and in the nails which are withdrawn without being bent or deprived of their heads. The nails used in these cases are generally of the variety known as wire or French nails. They are very tenacious, and well suited for much of the work which will be done by the amateur.

For holding and screwing up gas or water pipes and fittings, a wrench with serrated jaws of the form shown in Pl. VIII is required.

A vice is indispensable to the amateur, and he should provide himself with both a hand-vice, which, as its name implies, can be held in one hand, while the file, etc., be applied with the other hand to the object held within its jaws, and a bench vice, which can be attached to the bench and removed at pleasure. The bench vice will, of course, hold larger objects and pieces of material than the hand-vice, and as it is securely fastened and holds the work rigidly; the operator has both hands free for any process in which he may be engaged.

The ordinary form of hand-vice is a pair of strong jaws connected at one end by a strong rivet on which they turn. A spring which is attached to one of them and works against the inside of the other tends to keep them apart. The jaws are brought together by means of a screw fitted with a wing-nut. The ordinary form is shown in Pl. VIII. An improved pattern, in which the jaws are made to open parallel is also illustrated; with these a much firmer grip can be obtained than with the old pattern.

Bench vices are similar to hand-vices in principle, but are of a much more solid construction. The width of the jaws varies from about 2 in. to 6 in., and the extent of the opening corresponds with the size of the vice. Most amateurs will find a vice with 3½ in. jaws large enough for all ordinary purposes. Many artisans still favour the old-fashioned leg-vice (Pl. XI). This form is certainly very rigid, as the extension piece rests firmly on the ground, and the vice is therefore independent of the stability of the bench or table to which it is attached. These vices are curiously sold by weight. The 3½ in. size weighs

about 27 lb. It is capable of standing a good deal of rough usage, and for this reason may be generally preferred where much hammering is done. The most serviceable vice for the ordinary amateur will, however, be found in the improved parallel vice which is now in common use in all large workshops. It is made of iron and neatly painted, with the exception of the jaws, the handle, the head of the screw and the box, which are finished bright. At the bottom is a T-shaped plate or sole, $\frac{1}{2}$ in. thick, to which the fixed jaw of the vice is fixed with four bolts. The movable portion of the vice, having the jaw at one end, is a hollow box-shaped piece of iron. This box moves backward and forward on the sole under the action of the screw by which the vice is worked. The jaws are fitted with cast-steel roughened faces. It is attached to the bench by means of bolts which pass through tongue-shaped extensions of the sole on each side, and also an iron plate fixed on the under side of the bench. The nuts which are screwed on the ends of the bolts work against the plate, and the pressure of the screws is thus distributed over a larger area of the wood. In the latest patterns, a movable jaw may slide easily in or out to suit the size of the work which is being held, and the screw is only then made by the action of a clutch to come into operation. It will be seen that much time is thus saved. This vice is shown in Pl. VII. It should be mentioned that it is somewhat more expensive than the ordinary form of vice, but where much in use, its great advantages will be found to more than compensate for the additional cost.

In connexion with the use of vices, it is often desirable to protect the surface of the material which is being held from being marked by the roughened steel faces of the vice-jaws. For this purpose the amateur should provide himself with one or two pairs of caps of wood, lead and copper respectively, to fit over the jaws and to be used when necessary. In the case of brass work, for instance, either the lead or copper caps should be fixed on the jaws of the vice. For objects made of softer material, the wooden caps should be used. These caps are obtainable at all tool shops, but modified forms of them can be made without difficulty. The copper and lead caps can be made by the very simple process of gripping two pieces of these metals in the vice and hammering them down over the jaws. In the case of the copper caps, the metal may be quite thin, say $\frac{1}{16}$ in.; the lead should be not less than $\frac{3}{16}$ in.

The various kinds of grip vices used only as adjuncts to the

carpenter's bench will be dealt with in connexion with the description of the bench itself (see p. 138).

The **clamp** or **cramp** is a contrivance used for holding boards close together and retaining them in position until they are fixed in their place by screws or nails. It is also used by cabinet-makers for bringing glued work together, and keeping the parts in close juxtaposition until the glue has set. The principle upon which the cramp works may be seen from the illustration in Pl. VII. One movable head works along an iron bar and and may be fixed in position at any part of the bar. The other head is also movable, but only to the extent of the screw to which it is attached. When the heads have been fixed so as to allow the work to slip in easily between them, the boards or pieces of wood can be brought tightly together by the action of the screw. These cramps, commonly known as joiner's or sash cramps, range from 3 ft. to 7 ft. in length.

In Pl. VIII is shown an Adjustable G Cramp, a handy article for amateurs for small work. It is made of malleable iron, and is of great strength. By turning the bolt one-quarter to the left, it can be moved its full length out or in; when turning it to the right, it operates like any other screw.

The old-fashioned wooden hand-screws (Pls. I and XXVI) are also useful for clamping. They consist of two parallel jaws or blocks of wood, which are brought together or parted, as may be desired, by two wooden screws running transversely through the bars and working in opposite directions.

For bringing the glued edges of boards tightly together a simple cramp may be quickly improvised in the following manner. At the ends of a piece of board, about 3 or 4 in. wide and a few inches longer than the joint width of the boards which are being glued, are screwed two blocks of wood, so as to allow the boards to lie between them with a space of an inch or two between their edge and one of the blocks. A strip of wood somewhat thicker than the boards is then laid against them, and in the remaining space are inserted a pair of wedges, made so as to fold together. The more the wedges are driven, the greater will be the pressure on the edges of the boards. If the boards are of some length three of these clamps may be used, one at each end and one about the middle. When the glued edges have been pressed together by the action of the wedges, the work should be left for the glue to dry. The best way of releasing it is to knock out the slip of wood between the wedges and the board.

The **hold-fast** is a form of bench clamp used for holding work firmly on a bench for carving, sawing, planing or any other similar purpose. The form in general use is shown in Pl. VII. No fitting is required, but a hole is cut in the top of the bench large enough to receive the shaft of the clamp. When this is inserted it drops down through the bend until the adjustable foot rests on the object to be held and a slight turn of the screw then binds it with great pressure. The clamp can be swung round in any direction or removed at pleasure, as it is not fastened to the bench in any way. The more the screw is turned, the harder the shaft binds in the bench. The pressure foot is pivoted so as to conform to the surface of the wood placed beneath it. In order to ensure a firm grip it is serrated. The appliance may be regarded as a most desirable and handy tool for all carpenters and wood-workers.

Tools for Guidance and Direction in Laying-off and for Testing Work.—In good carpentry and joinery much depends on accuracy in measurement and in fitting parts together at the required angle. In order to ensure this accuracy, various tools of guidance and direction are used. Without these it would be impossible even for a skilled carpenter or joiner to do his work and fit his material together with that nicety which is essential in many of the operations which he performs. Thus, for setting out a long, straight line in ripping down a board, a **line and reel** is required, and for measurement of the length, breadth and thickness of material, the **carpenter's rule** is needed. For cutting across a board at right angles to the edge and for mortising and similar operations, a **square** must be used, and for cutting wood at any given angle to the edge, the proper line of direction for the saw must be marked with the aid of the **bevel.** When cutting or planing down wood to a uniform thickness the necessary lines must be made with a **marking gauge,** while in mortising the **mortise gauge** is used. For joining pieces of wood at right angles, as in making a picture frame, recourse must be had to the **mitre-box.** When subdividing any given length or marking out circles or arcs with various radii, the **compasses** or **dividers** are brought into requisition. In turning in the lathe, to make sure of getting the diameter of the various parts of the work to correspond strictly with those of the pattern, these diameters must be tried and regulated as the work goes on by means of the **callipers.** In fixing horizontal bars and shelves at a true level a **spirit-level** is

required, and in fixing a post in the ground or a piece of quartering to the wall, the perpendicular line is found by means of the **plumb level** with cord and plumb-bob. A **straight edge** is useful for testing the accuracy with which the surface of wood has been planed up and for other purposes. It is desirable, therefore, to obtain some knowledge of such appliances and of the manner in which they are used.

The **line and reel** is a simple appliance costing but a few pence, and is not generally found in price lists. Any large-sized reel will do provided that it be deep enough to carry some few yards of line or cord which, in order that it may do its work effectually, should not be of a very elastic character. In marking a long board which it is desired to cut down, the line is used in the following manner. A knot and loop are made in the end of the line, and through the loop is passed a fine bradawl which is pushed deeply into the wood precisely at the point at which the saw cut is to be commenced. Another bradawl is inserted at the other end of the board where the cut is to finish, and the line is strained from one bradawl to the other and securely fastened. Before the line is strained it should be whitened with chalk or blackened with charcoal. If it be then lifted perpendicularly from the surface of the board with the finger and thumb of the right hand and released suddenly, it will strike the board smartly along its length, leaving a white or a black mark in a perfectly straight line from bradawl to bradawl. This line will serve as a guide for the saw. In using the saw amateurs are apt to exert pressure on one side or the other, and this causes the saw-cut to diverge from the straight line. It is desirable, therefore, to repeat the operation with the chalk or charcoal line on the other side of the board, the bradawls being allowed to remain in their places to ensure accuracy of register. The under part of the board may then be examined from time to time to see that the saw cut is closely following the line. This method of marking, which is illustrated in Pl. XIII, Fig. 1, is usually adopted when the board to be sawn is rough on the edges. When the edges have been made straight and true, the operation may be performed either (1) by setting off points at equal distances from the edge by means of the rule and connecting these points by drawing lines with the straight edge; or (2) the pencil point may be held against the end of a rule and, with the left holding the rule at the required distance, and acting as a guide or fence, a continuous line parallel to the edge may be traced down the whole length of the board in the manner shown in Pl. XIII, Fig. 4.

The **carpenter's rule** is a well-known instrument consisting generally of two pieces of boxwood each a foot in length joined at one end by a flat brass joint and tipped with brass to prevent wear at the other ends. They are divided into inches, which are sub-divided into 8ths and sometimes 16ths. Rules may also be obtained in brass, iron or steel. For carrying in the pocket the narrow four-fold rule will be found convenient. A rule which will be found very useful for accurately gauging thicknesses, is one fitted with a calliper slide attachment The diameter or gauge of any work is measured between the inside of the foot of the slide and the end of the rule, and is indicated by the graduations on the slide. This rule, which is made of boxwood with arch-joint and edge plates in brass, is four-fold; it is 12 in. long and 1 in. wide, and graduated in 8ths, 10ths, 12ths and 16ths of an inch.

The **try-square** (Pl. I), which will be found indispensable to the amateur carpenter for setting out or testing work, consists of a steel blade set at right angles to the inside face of the stock in which it is held. The stock itself is always faced with brass in order to preserve the wood from injury, and is of ebony or rosewood. Squares are made with blades varying from 3 in. to 15 in. in length, and the prices vary in accordance with the length of the blade. For all ordinary purposes the 9 in. square will be found sufficient. The square is used, as its name implies, when drawing straight lines at right angles to the edge of any piece of wood or board, and the blade is therefore fixed and held true in the stock or handle. The stock is about ½ in. in thickness, so that its face may be applied to the edge of the wood, and the steel blade laid on the surface which requires marking.

A square of which the blade has, owing to a fall or other accident, been moved out of truth, is a continual source of trouble and annoyance until the defect is remedied and on this account every care should be taken to protect it from ill usage. Toolmakers in their catalogues sometimes impress this fact upon customers by warning them that in stamping their names on the square they should on no account stamp on the brass shield covering the rivets, as the operation will throw the square out of truth and state that squares thus stamped will not be exchanged. If there is any reason to doubt the accuracy of the square, it should be tested by being applied to a piece of wood properly squared up and trued on one face. From this face a pencil line should be drawn along the outer edge of the blade. The

square should then be reversed, the stock being placed against the wood in the opposite direction and the outer edge of the blade along the pencil line. If the edge of the blade and the pencil line coincide, the square is true ; if they do not, the square is out of truth and is useless until rectified. This is by no means an easy matter, as it can only be done by a careful filing or grinding of the parallel edges of the blade.

In dealing with squares, mention may be made of what are known as **combination squares**. These instruments are well made, neatly finished and are very accurate. When fitted to the adjustable scale or rule supplied with it the combination square forms an extremely convenient and useful tool, being a complete substitute for a whole set of ordinary try-squares. It is also useful as a gauge for transferring exact measurements or laying out work, as a depth gauge, for squaring in a mortise and for marking out a mitre. The blade of the rule is hardened and graduated with readings both ways.

The **bevel** (Pl. VIII) is closely allied in character to the square, and is used for drawing straight lines at any desired angle to the edge of the wood. While, therefore, the blade of the square is fixed, that of the bevel is adjustable. The stock is made of hard wood, generally rose-wood or ebony, and has brass mountings at each end. The blade is of fine steel, spring tempered, with perfectly parallel edges, and slotted so as to allow it to be moved along on or pivoted round the screw pin at the end of the stock. When the blade has been moved round to form any required angle with the stock, it may be fixed securely by tightening the screw. Care should be taken when selecting this tool to see that the edges are straight and parallel, and also that the stock when screwed up grips the blade firmly without bending it. The manner of using this tool is shown in Pl. XVIII.

The **marking gauge** (Pl. I) is a tool used to make lines or marks parallel to the edge of a piece of wood.

It consists of a stem or bar, usually of beech-wood, with a head or stock of the same material which slides along the stem and is retained in any desired position by a thumb-screw. A steel spur, or sometimes a steel point, is inserted close to the upper end, and when it is desired to mark a line parallel to the edge of the wood the head is moved along the bar until the required distance between the steel point and the upper surface

of the head is obtained, when it is secured firmly in position by a turn of the thumb screw. The head is then held against the edge of the wood with the steel point pressing on the surface, which, as the gauge is moved along, marks or cuts a line. The steel spur is flat on one side, and bevelled or rounded on the other. When inserted in the stem the bevelled side should be turned towards the stock, so that when the gauge is pushed along the board, the shape of the spur will give the tool a tendency to draw inwards and thus keep the stock well up to the edge of the wood. If the tooth were placed with the flat side towards the stock the tendency would be to come towards the edge and constant effort would be required to keep the stock pressed against the edge with the result that a series of scratches, instead of a clean cut would be made.

A good gauge may be known by the clearness of the mortise through the stock, the straightness of the stem and the quality of the screw. The stock and stem should make a good fit.

The mortise gauge, also shown in Pl. I, is similar in principle to the marking gauge, but has, in addition, a slide working in a groove in the lower side of the stem, by means of which two lines parallel to each other and to the edge of the wood may be marked at one operation, the steel point in the groove and the head of the gauge being set at the required distances from the fixed steel point. The points of the spurs are made to cut on both edges, and are rounded somewhat on both sides. As there are two teeth, the liability to run out of the straight line is not very great. During recent years, there have been introduced excellent combination gauges for both marking and mortising, and these may be commended to the notice of the amateur artisan. There are many other varieties of gauges, such as butt gauges and panel gauges, used by carpenters and joiners for special work, but they are beyond the scope of the ordinary amateur.

For curved work, however, it may not be amiss to call attention to a new pattern marking gauge with an adjustable face which can be arranged so as to conform to the contour of the work (Pl. VIII). With this gauge a line can be traced with perfect accuracy around curves of any degree, whether concave or convex. The gauge is set by loosening the thumb-screw on the upper side of the gauge and pressing the face of the instrument against the edge of the work, so that it accommodates itself to the work, and the thumb-screw is then tightened again. Double-

line gauging is accomplished by means of a shifting marker, carried on a sliding plate. The sliding plate is mounted in a slot in the gauge bar and is adjusted and secured in position by means of a thumb-screw. When necessary the adjustable plate and marker can be readily removed. An advantage of the gauge is that there is no block to obstruct the movement of the hand when holding it.

A very simple little appliance which may be made by the amateur himself and attached to any ordinary gauge for the purpose of adapting it for curved work, consists of a small brass plate with two half-round ribs which may be fixed on one side of the gauge-head. In working round a curve both of the ribs press against the edge of the work, so that the spur or point of the gauge marks at a uniform distance along the whole length of the line.

In using the marking gauge for single lines and the mortising gauge for double lines straight in both cases and parallel to the edge of the wood on the surface of which the marks are made, the object is to preserve the distance at which the points are set from the head or stock of the gauge when marking, perhaps, several parts of the work in the same manner, as, for example, when cutting mortises and tenons. When the point or points have been accurately adjusted to the desired distance from the head, the bar and stock of the tool should be grasped in whichever hand may be more convenient having regard to the position of the work, in such a manner that the thumb is pressed against that side of the stem nearest the operator and the forefinger laid over the top of the stock and the opposite side. The head of the gauge should be held firmly against the edge of the wood with the spur or point lightly touching the surface. The gauge should be pushed along so as to make a fine cut in one operation from one end of the wood to the other. If the cut is not deep enough, the process should be repeated. The points should not project too much from the stem, or they will drag in the wood and prevent the operator from doing the work quickly and easily (Pl. XIII).

A **level**, as the name implies, is an instrument for ascertaining whether the surface of a piece of wood, such as a shelf or a cross-bar, is in a perfectly horizontal position, and also without inclination to one side or the other. The joists of a floor must be tested with this instrument in order to ensure that when the boards are nailed down the flooring itself may be quite level. The level is also used for ascertaining whether stones or courses of

brickwork are properly laid and whether posts, framing and all work consisting of uprights or vertical pieces of any kind are truly perpendicular, that is to say, at right angles to the plane of the horizon. To determine whether or not carpenters' and bricklayers work is either level or upright, different kinds of levels are used.

The **spirit level** is an instrument of great utility, which every amateur should possess. The illustration (Pl. VII) shows the kind of level in ordinary use and its general principle. The body is generally made of some hard wood such as walnut, rosewood or ebony. In the upper part of the wood a groove is cut just deep enough and long enough to receive a round glass tube nearly filled with spirit and hermetically sealed at both ends to prevent the escape of the fluid thus imprisoned within it. When the tube has been properly placed in the groove cut for its reception, the upper surface should be just flush with the upper surface of the wood. A thin brass plate with a long narrow hole in the centre is fixed over the glass and wood. To protect the bottom of the level, plates of brass are sometimes attached to it at the ends. The small space in the tube not filled with spirit takes the form of a bubble, and this bubble, being lighter than spirit, will always rise to that part of the tube which happens to be highest. When the tube is in a fairly horizontal position, the bubble takes an elongated form which shifts from end to end as each is raised and lowered in turn. When the level rests in a perfectly horizontal position, the bubble remains precisely in the centre of the tube. In practice, therefore, if, when the level is laid on a shelf or other piece which is being fixed in a horizontal position the bubble is found to be in the middle of the tube, the shelf or piece of wood is exactly in the desired position and truly level. If it is too high at one end, the movement of the bubble towards that end will show that either one end should be raised, or the other lowered, whichever may be the more convenient.

It may happen, however, that the shelf itself is level, but that this is not indicated by the bubble in the spirit level. The reason will be found in the fact that the surface of the wood upon which the level rests is not perfectly true, or, in other words, has not been properly planed up. The depressions or irregularities in the surface, though so small in themselves, are in this case sufficient to give an inclination to the instrument when placed in any particular position on the shelf, whilst by slightly

shifting the position of the level, a quite contrary inclination may be observable. This is simply because the spirit-level is, comparatively speaking, short, being seldom more than 10 in. in length, and will only indicate the true level with accuracy *for its own length* unless the wood has been worked up so that its surface is smooth and level from end to end. To get over any difficulty of the kind to which reference has been made, the amateur may provide himself with what may be termed a double straight-edge. In this double straight-edge, which should be about 5 or 6 ft. in length, the sides must be perfectly true, level and parallel to each other. When such a piece of wood as this is laid along edgewise upon an irregular surface, its inclination is not affected by any slight depression which may occur between the two extremities and will, therefore, give a much more reliable test when the spirit level is placed upon it, instead of upon the rough or uneven surface of the wood.

The straight-edge above described may be further utilized in another way, namely, as a plumb-level. A hole, shaped something like a pear when cut in halves longitudinally, may be made near one end of the straight edge as in Pl. XXVIII, and three shallow cuts with a saw at the other end. The middle cut should be exactly on a straight line drawn exactly down the middle of the board from end to end, and the pear-shaped hole should be cut so that it is symmetrically divided by this central straight line. A piece of string or cord, not too thick, is then threaded through a hole made for the purpose in a leaden or brass plummet, commonly called a plumb-bob, and a knot tied at the end. The other end of the string is slipped into the middle cut at the top of the plumb level and after being adjusted in such a manner that the plumb-bob hangs freely within the hole is secured by being wound into the other saw-cuts. If, when the plumb level thus made is applied against a wall, as shown in the illustration, or to a post which is being fixed in the earth the plumb-bob, when hanging freely, is in such a position that the string covers the centre line marked down the board throughout its whole length, the wall or post is perpendicular. If, however, it inclines to the right or left, the weight of the plumb-bob will carry the string out of the central line. In the case of a post let into the earth, it is necessary to try it with the level on two contiguous faces to ensure perfect accuracy of position.

The **A level**, shown in Pl. XXVIII, is so called from its

resemblance to the letter A, and is merely an adaptation of the plumb-level for determining the accuracy with which level courses of bricks are laid, or for testing stonework of any kind, such as paving or steps.

In this case a plumb-level is set perpendicularly or at right angles to the straight edge, which is generally from 5 to 8 ft. in length. When the straight edge is placed on the last course of bricks laid on the brick wall which is being built, the bricklayer can judge of the accuracy of his work by the position of the plumb-line, which acts in the same manner as it does in the simple plumb level. In a similar manner the mason may ascertain whether or not the stones he has placed in position, or the pavement which he has laid, is level, and the carpenter may test the level of the joists on the wall plate which he is about to fix.

The **shooting-board,** or **shuteing-board** (Pl. B, Fig. 1), in its simplest form consists merely of two boards of different widths screwed together so as to form a rebate in which a board or other piece of wood, the edges of which are to be planed true and squared, may be rested. Such an appliance will be found by the amateur to be very useful. Although it would appear very easy to make, unless it is perfectly accurate it is worse than useless and the beginner would therefore be well advised not to attempt the task himself but rather to buy one of a reliable tool-maker or to have it made by an expert carpenter. In practice, the shooting board is laid on the bench and either abutted against the bench stop or held firmly in position by gripping a wing fixed to its edge in the bench vice. The jack-plane or trying-plane is laid on its side on the lower board, so that its cutting iron is turned towards and touches the edge of the wood which is to be trued and squared up. The operation of planing is performed with the tool in this position, the side being slid along the board from end to end of the work, the edge of the upper part of the shooting-board acting as a guide to the sole of the plane (Pl. III, Fig. 3). A defect of the ordinary shooting-board as described above is that owing to the grain of the wood being all in one direction it is liable to warp. As a remedy, two or three rails are often mortised into the lower board or rail and the upper board is fastened with screws to these rails. A small space may in this way be left between the two boards so as to permit the shavings to fall through. The length of the board may be from 2 ft. 6 in. to 3 ft. 6 in. and the width about 8 in. A key of

hard wood or a cross rail is fixed across one end. In an improved shooting board with a sliding parallel fence which may be adjusted according to the width of the board to be planed, two grooves are cut in the upper board at right angles to the edge. In each of these grooves travels backwards or forwards the shank of a thumb-screw bolt which enters the lower board. When this screw is loosened, the upper board can be moved to any desired distance from the outer edge and then secured by turning screw. The grooves act as guides, and, together with the cross-piece or key let in at the end of the board, also at a perfect right angle to the edges, ensure a parallel movement of the upper board.

The **mitre-block** is shown in Pl. I. It is nothing more than a block of beech carefully squared and trued up and rebated so as to present throughout its length a rectangular step-like recess in which the wood to be mitred is placed in order to be cut at the necessary angle. In the raised parts three saw kerfs are made, two at an angle of 45° with the sides of the mitre-box and one half way between these at right angles to the sides. The inclination of the saw-cuts at an angle of 45° is to the right and left respectively, so that when these angles are brought together in the mitred joint they may form a perfect right angle (90°). If the saw-cuts have been made at a correct angle, the mitre-joint will be correct, but, on the other hand, the slightest inaccuracy will be plainly apparent when the parts of the mitred frame or work are brought together. Care should therefore be taken to prove the mitre-block, i.e. to test it thoroughly in order to ascertain that it is perfectly true. The saw-cut at right angles to the edges is mainly useful in squaring off the end of the wood and in testing the accuracy of the mitre-joint by means of the diagonal cuts. Mitre-blocks of beech as shown in the illustration are made 9, 12 and 16 in. respectively.

The **mitre-box** (Pl. B) is used for purposes similar to those of the mitre-block, but is a trough or channel of wood or metal composed of a bottom piece and two raised sides in which saw-cuts are made transversely through both sides in the same directions as in the mitre-block. The wood to be mitred is placed in this channel, and the tenon-saw, being guided by the saw-cuts, is maintained at the correct angle.

For fine work, such as picture-framing, a **mitre** shooting-board (Pl. B, Fig. 10) is used. In general principle and construction, this appliance is similar to the ordinary square shoot or shooting-board.

The important difference is that the faces of the stop, instead of being at right angles to the edges of the board, are fixed so as to form a "true mitre," being set across the shooting-board precisely at an angle of 45° to the right and left respectively.

Templets for squaring up the ends of wood and for marking out and paring mitres are also obtainable in brass and iron. The chief advantage which they possess is great accuracy. The cost is very small, in some cases only a few pence.

Compasses are used for marking out circles or arcs of circles, for transferring measurements and for scribing. Those used by carpenters are made of iron, the legs being strong and solid. Pl. VIII shows the pattern in common use. It is known as the Lancashire wing compass. These compasses are made in various sizes, from 5 in. to 12 in. They are provided with a wing which is fastened to one of the legs, and passes through a slot in the opposite leg. This leg works freely on the wing which is in the form of an arc of 45°, so that the compasses may be extended until the legs form a right angle. A thumb-screw works in the thick part of the movable leg and is screwed down on the wing to fix the compasses at any particular set so that the leg may not be made to deviate from its course by the point working into the fibre of the wood.

Dividers (Pl. VIII) are similar to compasses in their construction, but are used more particularly for transferring exact measurements or for marking off a number of equal spaces. Generally speaking, they may be regarded as the compasses used by metal-workers and draughtsmen, and in commercial price lists will be found classified with tools used in the metal-working and engineering trades.

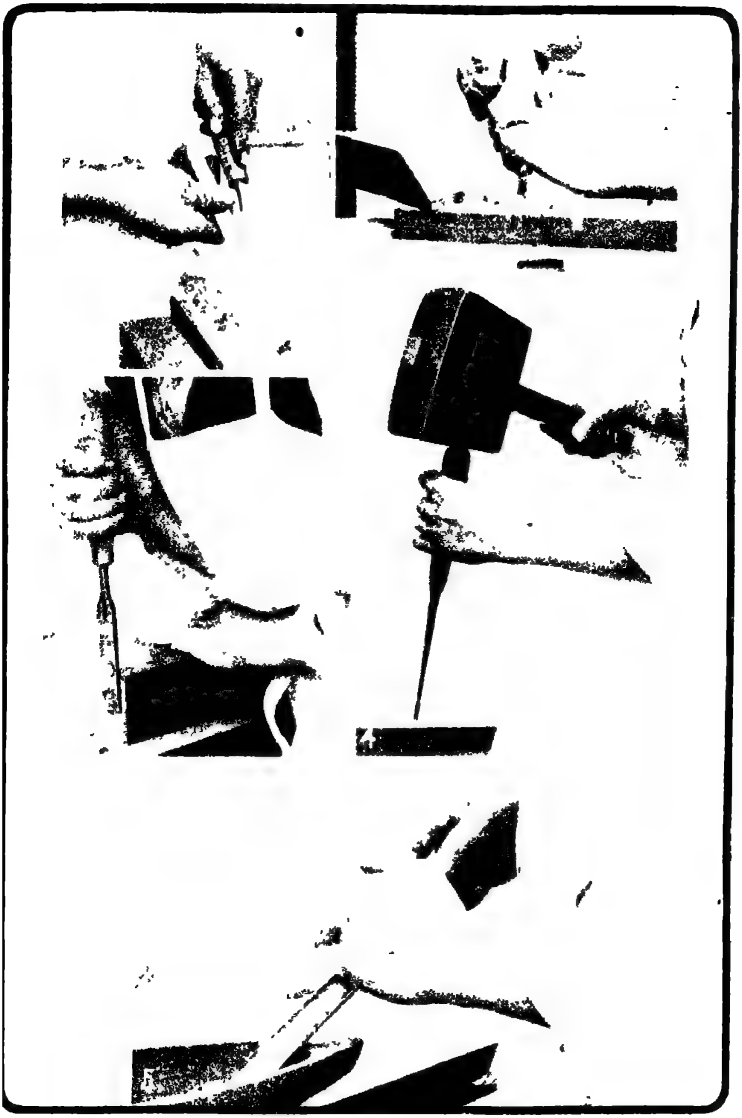
Callipers are occasionally used by carpenters and joiners for gauging the diameters of round pins or rods or of circular holes or recesses. For the former purpose, callipers of the form shown in Pl. XXIII and known as outside callipers are used; for the latter purpose, inside callipers (Pl. XXIV) are necessary. Reference to calliper rules for gauging the thickness of material has been made on a previous page (p. 72).

Miscellaneous Tools.—There are many miscellaneous tools used in carpentry and joinery which are not subject to any classification as are those which have already been described. Among

Plate V USE OF TOOLS

(1) Using a hatchet (2) Chamfering with draw knife (3) Home made s[illegible] (4) Using spokeshave in curved work

Plate VI. CHISELS



(1) Making a wooden pin (2) Cutting groove with chisel (3) Vertical paring (4) Cutting a mortise (5) Manner of holding gouge

these may be mentioned the turn-screw or screw-driver, the nail-set, the reamer or rimer, the marking knife, etc.

The **turn-screw** or **screw-driver** bears some slight resemblance to the chisel, but is used for a very different purpose. It is a blade set in a wooden handle with the edge ground so as to form a long bevel on either side. The edge is blunt, but should be fine enough to enter with ease the slot in the head of a screw. In Pl. VII is shown what is known as the London pattern of screw-driver, or turn-screw as it is generally termed by dealers in tools. In this pattern the blade is flat throughout its length. The heel of the blade just above the tang fits into a slot cut in the ferrule, and the blade is thus prevented from turning in the handle when under a strain. With it is also shown the cabinet or spindle-blade pattern, a form closely resembling that used by the engineer or metal-worker. For certain work a turn screw with a specially long spindle blade is required. In other cases such as in fixing a lock on the inside of a drawer where the space is restricted only a very short tool, such as that illustrated in Pl. VIII, can be used. For the use of electricians, who sometimes have to insert screws through a hole in an insulator, where an ordinary blade would not enter, a tool with a long narrow blade, such as that shown in Pl. VII, is necessary. These turn-screws are made with $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in. points.

Reference to the turn-screw bit has already been made in connexion with the description of the brace and bits. This tool will be found to be of great convenience in all cases where considerable power is required, as in driving screws of a large size or when the wood is hard. In Pl. IX is shown a hand forged round screw-driver bit which is stated by the makers to be capable of standing a great strain. These bits are made in 5 in. and 8 in. sizes. The screw-driver bit, in combination with the brace, will also be found very useful where a large number of screws have to be driven, as in addition to the powerful leverage obtained by the wide sweep of the brace the action, being continuous, is very rapid.

For all ordinary purposes of carpentry and joinery it will be sufficient if the amateur provides himself with three screw-drivers—one with an 8-in. or 10 in. blade for heavier work, one of medium size and a short one for drawer locks, for loosening and fixing plane-irons and also for general bench work Any of the other patterns of turn screw should only be obtained as the special need arises.

Nail sets or punches are simply pieces of steel or case-hardened iron, square, round or octagonal in section, about 4 in. in length and from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. in width or diameter, as the case may be, at the larger end. At the smaller end they taper to a blunt point, which may be square, oblong or circular in form. They are used to drive the heads of nails or brads below the surface of the wood, so as to prevent disfigurement of the work, either by their projection or by rusting on exposure to the weather. When the head of the nail has been driven slightly below the surface of the wood the depression can be filled up with putty. When a nail is to be punched in, it should not be struck directly with the hammer after the head is about $\frac{1}{16}$ in. above the surface of the wood, lest the wood should be bruised or indented with the hammer. The nail-punch should then be brought into operation and used to drive the nail into the wood. In nailing down floor boards it is particularly important that the head of the nail should be sunk below the surface as otherwise the wearing of the boards will in time cause the iron to project from the floor and become a source of danger. In practice, the punch should be grasped by the thumb and forefinger of the left hand, as in Pl. XI, and steadied by the second and third finger in the manner shown, while the little finger rests on the surface of the wood. The worker is in this way able to hold the tool firmly against the head of the nail and avoid the risk of slipping and consequent damage to the surface of the wood. The blows of the hammer should be delivered quickly and smartly.

The **reamer, or rimer** as it is often called, is a steel tool set in a handle and used for the purpose of enlarging a hole in a piece of metal, as, for example, in a hinge in which the screw-holes are not quite large enough to admit the screws. It is made in different forms, but usually in the shape of a long stiletto-like four-sided blade, thick at the haft and tapering to a fine point. This point may be used for marking lines on wood, metal or any other material. On account of being put to this use the tool is sometimes called a **scriber**.

Useful Aids in Household Carpentry.—Under this heading mention may be made in the first place of the **Carpenter's Pencil**, which will be in constant use by the amateur when setting out work by marking lines with the aid of the rule, square and bevel. Pencils for carpenter's use are square, round or oval in form and of these shapes the oval will be found best for general purposes.

The pencil should be sharpened to a sharp chisel edge, as the ordinary pointed pencil would wear down after a very little use and so produce a thick and ill-defined line. The greater bearing surface of the chisel edge will allow the pencil to be used to a much greater extent before it requires to be re-sharpened. In order to avoid loss of time in looking for the pencil, which from its character may be easily mislaid in a workshop, it will be well for the amateur to provide himself with a dozen of these and to prepare them for use.

In laying-off a job it is sometimes convenient to be able to mark intersecting lines of different colours. For this purpose, special crayons (red, blue, green and black) are sold, and will be found very satisfactory in fulfilling their purpose.

Whilst the pencil is certainly the simplest and best marking tool for large work or for rough surfaces, for all work requiring great precision and for smooth surfaces a **striking knife and marking awl** (Pl. VIII) must be used.

An excellent home-made striking knife may be obtained by grinding down an old table-knife or carving-knife or by similarly dealing with the part of a broken knife remaining in the handle.

The **glue-pot** may be regarded as an essential in every house, whether the occupier turns his attention to household carpentry or not. So many little odd jobs can be done with its aid that in general usefulness it ranks immediately after the hammer and screw-driver.

The ordinary glue-pot (Pl. VII) consists of an outer and an inner vessel, the outer and larger one being of iron and the smaller one of copper or iron, as the case may be. Glue-pots are made in many sizes, holding from ¼ pint to as much as 8 pints. The glue is contained in the inner vessel. The outer vessel is kept about half filled with water. This arrangement is adopted in order to keep the temperature just under the boiling point of water and so prevent burning of the glue.

Excellent household glue-pots may be easily made by the adaptation of the ordinary tins in which such commodities as golden syrup and tomatoes are received from the grocer. The smaller or inner vessels may be made from cocoa or mustard tins. In the top of the larger tin, a hole should be cut sufficiently large to easily admit the smaller, the top of which should be snipped for about half an inch and turned down so as to form a flange which will support it and raise it from the

bottom of the larger vessel. In this way there can be no risk of over-heating the glue as it will be completely surrounded with a water-jacket. For convenience in lifting, handles of stiff wire may be fitted to each of the vessels. In the smaller tin, two of the pieces cut to form the flange may be left standing on opposite sides of the tin for this purpose. The amateur will find no difficulty in devising many other forms of such a glue-pot, all equally serviceable.

In purchasing a **glue-brush** care should be taken to see that it is of good quality. A small brush used by painters and usually called a sash tool will be very suitable for the purpose of applying the glue. Before being used the brush should be soaked for a few hours in water. This will be found to prevent the bristles from coming out and so rendering the glue quite useless. It is advisable not to leave the brush in the glue, but after it has been used, to wash it out in hot water and put it away for future use. If allowed to remain in the glue, the hairs soon become bent round in one direction and the brush is then far less serviceable, at any rate, for fine work.

The ordinary workshop method of **preparing glue** is to break it up into small pieces and place it in the smaller of the two vessels forming the glue-pot, adding sufficient water to just cover it. The outer pot is then nearly filled with cold water and steadily boiled. The glue is constantly stirred while it is melting and when quite dissolved should be of the same consistency as good linseed oil and should run from the brush freely in a steady stream, just as oil would run. If it does not run freely, but breaks into drops, it is too thick, and a little water from the outer pot should be added. The scum which appears on the surface during the process of boiling should be removed.

An alternative method of preparing glue is to break it into small pieces and soak it from twelve to twenty-four hours in cold water; it should then be put in the glue-pot, the outer pot filled with water and heat applied. For ordinary purposes it should run freely and be of the consistency of thin treacle. The hotter glue is, the more force it will exert in keeping the two parts glued together; in all large and long joints the glue should be applied immediately after boiling. Glue loses much of its strength by being often melted; that glue, therefore, which is newly made is much preferable to that which has been used. When done with, some of the boiling water from the outer vessel should be added to the glue so as to make it too thin for immediate use. It should then be put away till wanted

again, and by the time the water in the outer vessel is boiled the glue in the inner vessel is ready melted and the proper thickness for use.

With regard to the glue itself it may be interesting to the reader to know that it is made from parings of horns, hoofs and skins of oxen and from similar products. These substances are boiled and strained, and after being submitted to several refining processes is poured into troughs or moulds and allowed to cool. It is then of the consistency of a jelly. This jelly is afterwards cut into slices and dried either naturally or by artificial means until it hardens into cakes of glue of the form commonly sold in shops. The "size" used by paper-hangers and others is merely glue which has not been subjected to the drying process and therefore retaining the form of jelly. Gelatine is similar in substance, but has undergone further refining processes.

The glue commonly used by carpenters and joiners is sold in two qualities—Scotch and French. The Russian and gelatine varieties are considerably more expensive and are not in such general use. "Town-glue" is a much cheaper and inferior quality.

Scotch glue has the reputation of being the strongest made. It is somewhat darker in appearance than the French glue, but both kinds should, when held up to the light, be uniformly transparent and free from muddiness or cloudy spots. French glue is usually made in much thinner sheets than Scotch glue.

Many methods of testing the quality of glue are recommended. When purchasing a small quantity, the readiest way will probably be to judge by the clearness. When larger quantities are used it will be advisable in the first place to obtain samples and submit them to further tests. Good glue when moistened and rubbed will at once become sticky. Greasiness is a sign of inferior quality. Cakes of glue which have been kept moderately dry should be hard and break clearly, though it should never be as brittle as glass. Good glue, when applied to wood, sets fairly quickly and is thoroughly dry in about twelve hours. If it should take very much longer it may be regarded as inferior in quality. Glue of poor quality may be further known by the odour given off when it is melted. There is very little smell from good glue, and it is never objectionable. The best qualities of glue will not dissolve in cold water, but will absorb far more water than inferior kinds. This fact alone suggests an easy test.

For all ordinary purposes, the amateur is recommended to use

either Scotch glue or a mixture of Scotch and French glue in equal parts.

During recent years, **liquid glues** have been introduced and have met with some favour. They are used for sticking not only wood, but also china, ivory, metal and glass. The advantages claimed for them are that they are always ready for use and require no heating or preparation, and that a saving of both time and labour is thus effected. Ordinary glue loses a part of its strength every time it is reheated. Liquid glue, on the other hand, retains its properties, and is not affected by exposure to the air excepting that it thickens and hardens from evaporation. On the whole, however, it cannot be regarded as being more efficient for its purpose than good glue properly applied, and if only on account of its cost, it is unlikely that it will be generally adopted as a substitute for the ordinary and much cheaper kind.

Glue may be made waterproof by the addition of bichromate of potash or chrome alum in the proportion of about one ounce to every pint of glue. The best way to prepare it is to have a small mixing tin in which is poured just sufficient glue to do the job in hand. A saturated solution of the chrome alum should be made and poured into the glue very slowly, the mixture being stirred briskly during the process. After a time the glue will suddenly leave the liquid state and become a stiff jelly. This must be avoided as far as possible by adding a little fresh glue. The preparation is at its best when it is just below the "jellifying" point. After exposure to strong sunlight the glue thus treated will be found to be quite insoluble, though remaining a perfect adhesive. The model boat builder who has found difficulty in planking his craft in such a way that it is perfectly watertight will fully appreciate the value of this simple recipe.

Several excellent "marine" or waterproof glues are obtainable commercially, but these are more in the nature of special cements than mere varieties of glue. Generally speaking it will be found that indiarubber and asphaltum enter largely into their composition, the solvents being petrol-ether, chloroform or naphtha. These materials are not readily accessible to the ordinary amateur and except in the special circumstances arising in connexion with experimental work the utility of such preparations is in no degree commensurate with the trouble of making them.

With regard to the actual process of gluing, it may be well to mention a few points, the observance of which makes all the difference between success and failure. In the first place, the glue should

be as hot as possible and whenever the work itself is of such a character that it can be warmed without fear of distortion of the surface this should be done. The glue should also be thin. It should be applied liberally, but should afterwards be squeezed out by firmly rubbing together the two parts to be joined so as to expel any air between them and to work the glue into the pores of the wood or to effect the same purpose by applying pressure, with clamps or by placing the work under weights. It must always be borne in mind that the thinner the film of glue between the surfaces of the wood the stronger will be the joint. The reason for applying it freely in the first place is to prevent it from becoming chilled before it sets. In joining work which has previously been glued, but has come apart great care should be taken to see that all the old glue has been removed. This may be done either by scraping and planing or by washing with hot water, but in the latter case the wood should be thoroughly dried before the fresh glue is applied. The surfaces should at all times be perfectly dry, clean and free from anything in the nature of grease. Under any other condition it will be impossible to get the glue to hold and it will peel off the wood. Glues vary considerably in respect of the times in which they set. Some qualities will dry in an hour or so whilst others are not dry after twenty-four hours. Good glue, whilst it does not set very quickly, will, when left in a moderately warm room, be quite dry at the end of twenty-four hours or even before.

The **oil-can** is indispensable in every carpenter's workshop and will be constantly in use. In its usual form, it closely resembles a funnel turned upside down, but instead of being open at the broad end it is furnished with a flexible bottom which can be pressed inwards with the thumb. When this is done the diminution of the space inside the can causes a small quantity of oil to be forced out of the nozzle. When released from the pressure of the thumb the bottom returns outwards with a short sharp click. The nozzle is of brass and is perforated lengthwise, the hole being just large enough to admit of the passage of a bristle or very fine wire. It screws into a brass cap which forms part of the body of the can and through which oil is poured when it is necessary to fill the can.

Another form of oil can is that commonly used by cyclists. It is compact. strong and tight and from its shape is suitable for carrying in the pocket. The body or reservoir is made of fine block-tin, flat like a watch and with flexible sides which give it a double spring. The nozzle is of heavy brass to insure

strength, it has a joint and is tinned inside to prevent corrosion of the oil. The brass cap is packed with hard leather which presses against the outlet of the nozzle as the cap is screwed down and effectually prevents leakage. Among other good points which this oil-can possesses, it may be mentioned that even if laid down with the nut off it will not leak unless pressed or jarred.

Besides the method already described of joining wood together with glue three other means are used and these are nailing, screwing and dowelling.

Nails are so made that under the blows of the hammer they force their way through the fibres of the wood. When driven in they are held tightly in position by the pressure of the fibres upon their sides. The tops of nails are flattened out into heads which assist materially in holding them.

There are many kinds of nails in general use and they are distinguished by various names and by variety of form. The sorts to which the attention of the amateur must be directed as being of use in carpentry and joinery are clasp nails, cut or wrought, rose-headed nails, clout nails, lath nails, wire nails, French and American tacks, joiner's brads, panel-pins and needle points. There are many others—it is estimated that there are about 300 kinds altogether—but the sorts mentioned above will meet all the ordinary needs of the amateur. Fancy nails and studs used in ornamental work and upholstery, such as for nailing a slip of leather or leather-cloth to the edge of a bookshelf or a piece of fringe to a mantel board will be mentioned in connexion with work of this kind.

The **cut clasp-nail** is a coarsely made common kind of nail with a rough head projecting slightly on two opposite sides. They are cut by machinery from a rolled sheet of iron. They are typical of a very large class of old-fashioned nails which are gradually being replaced in the market by the newer serrated steel nails. Cut-nails may be obtained in many sizes from $\frac{3}{4}$ in. to 6 in. in length. They are useful for all kinds of ordinary work, particularly in soft woods, but it must be remembered that they cannot be clinched or, in other words, that the end or point cannot be turned with the hammer and driven into the wood so as to prevent withdrawal. In order to avoid splitting the wood they should be driven in with the wider sides in the direction of the grain, and when placed near the end of a board holes should be bored for them. The peculiar wedge-shape section of cut-nails gives them a tendency to drift in the

direction of the wider side and when it is desired that they should enter the wood perfectly straight this tendency should be counteracted by inclining them slightly in the opposite direction. There are occasions, however, when the exact direction in which the nail is driven in is not such a matter of importance, and it will then be an advantage to allow the nail to cut its way across the fibres of the wood as in actual skew-nailing and so secure a stronger hold. This is particularly the case when the nail is driven into end grain.

Wrought clasp-nails are similar in form, but are much stronger, being made of malleable iron, the fibrous character of which permits of the nails being turned down and clenched. These should be used in preference to the cut nails whenever hard wood is used, or where strength is required. There are fine clasp-nails and strong clasp-nails ; the former, which weigh from 2 lb. to 6 lb. per thousand, are used in joinery, while the heavier and longer kinds are more suitable for carpentry. Sizes longer than 4 in. are generally known as **spikes**. It may be mentioned that the clasp nail is so called because through the peculiar barb-like form of the head it clasps the fibre of the wood into which it is driven as soon as it meets it and carries it down in its grasp. It leaves a somewhat large and ragged hole which can, however, be easily stopped with putty for painted work or coloured stopping in the case of polished work. This kind of nail can be easily driven down level with the surface without the aid of a punch, but if it is desired to bury the head the punch must be used.

The **rose-headed nail** is a wrought-iron nail with a round head projecting upwards in the centre. The body of the nail is broad and less in depth or thickness than in width. These nails are generally made with broad flat points, but sometimes with sharp points. They are very strong and are especially useful for such work as fencing. They are made in two varieties, fine rose and strong rose. The flat-pointed fine rose nails range from 1 in. to 3½ in. in length, fine nails range from 1½ in. to 3½ in. in length, the strong rose, also flat pointed, from 1¼ in. to 4 in. The best rose with sharp points range in length from 1½ in. to 3 in In using these nails it should be remembered that the chisel-pointed variety must always be driven in with the edge *across* the grain or the wedge shape of the nail will split the wood.

The **clout-nail** has a broad flat head and a round shank or body terminating in a sharp point. Like most of the nails already described, they are distinguished as fine clouts and strong clouts. Their peculiar form renders them well adapted for nailing ironwork or sheet iron to wood or for fastening down the tarred felt on the roof of a shed or fowl-house as the broad head keeps the material well down on the wood and cannot break through it as a smaller head would do. For holding down zinc to wood-work, galvanized nails of the same form should be used. Iron nails should not be used for this purpose as the galvanic action set up by the contact of the two metals, especially when wetted by rain or dew, will soon destroy the zinc all round the head of the nail. Copper nails could be employed, but they are very expensive.

The **lath-nail** used for nailing laths to quartering so as to form a foundation for the plaster when erecting a partition. The thin shank easily penetrates the lath and even if the lath splits when the nail is driven through it the two parts are held down to the quartering by the projecting head of the nail. It is not likely that the amateur will do much, if anything, with lath nails, but, as it is possible that he may wish to try his hand at repairing a damaged partition or ceiling attention has been drawn to the proper kind of nails to be used.

For rough-work such as nailing packing-cases together, **French nails** are much used. They are made of round wire and have large flat heads which are not punched in but allowed to lie flat on the surface of the wood. The body or shank is of uniform thickness throughout and terminates in a point. Just below the head it is ridged or grooved and this greatly increases its power of holding. There is a square variety of this nail, but they are more commonly seen in packing cases coming from abroad. French nails vary in length from 1 in. to 5 in., and are usually sold by weight. The amateur will readily understand that it is far more profitable to buy nails of all sorts in large rather than in small quantities. This is particularly the case with French nails, and it will therefore be desirable when purchasing to obtain sufficient to last for a considerable time.

The American variety of wire nail is oval in section. These nails may be used with very little risk of splitting the wood and, being formed with a sharp point, may be driven in almost any direction. Like the round wire nails the shanks are serrated near the heads.

The ordinary **iron or tinned tack** is too well known to need description. The French tack is merely a small variety of the French nail. The common tack is coarse and clumsy in make and is never used in carpentry. It may be found convenient, however, in fastening some textile fabric such as canvas or hessian to a wooden framework and for a few other simple household purposes.

Brads are, for the most part, long thin nails, tapering slightly from the head to the point, which is blunt, and having a slight projection on one side only of the head. Of brads there are many kinds. The **joiner's cut brad,** used in joinery and ordinary cabinet-making, varies in size from ½ in. to 2 in. The **flooring brad,** a coarser and heavier brad about 2½ in. in length, is used for nailing down flooring to the joists on which it rests. These brads are made in various weights per thousand and are distinguished by the number of pounds which a thousand weigh; thus, there are 10 lb., 12 lb., 14 lb. floor brads and so on. The brad used in fine cabinet-making is somewhat lighter and thinner than the joiner's cut brad, but in other respects the kinds are similar. All these brads are, from their form, well adapted for use where they are not subject to any great strain. They do not make such large holes as the ordinary cut nails, but owing to the slight bend at the point they are liable to draw from an upright into a somewhat sloping position as they are driven in. For this reason the hole bored with the bradawl for their reception should slightly incline in the direction required to counteract this tendency. The projecting head when driven down should not lie across the grain but parallel with it. In "secret nailing," sometimes adopted for securing a mitred joint in a frame or moulding the head of the brad is concealed by carefully lifting a chip along the grain with a bradawl or keen-edged narrow chisel (see Pl. X), and, after driving in the brad and punching it down, gluing down the chip and cleaning it off so that no marks are visible.

For use in special work where it is desirable that no rust stains should appear, brass brads are manufactured. Like the brass nails (to which reference has already been made) they are, however very expensive.

There is another kind of brad without any head generally used by glaziers to fix panes of glass before the putty is applied, and a further variety used by pattern-makers and others in which the head projects slightly beyond the body of the nail on

all sides. For many purposes, the form of brad commonly used by shoemakers will be found exceedingly useful. Owing to their serrated form they are very tenacious, especially in hard woods. Being light and thin, brads do not split the wood into which they are driven.

Needle-points are made of polished steel and are like ordinary coarse needles without eyes. They are used for fixing fine panels or thin mouldings. Needle-points are made of various degrees of fineness, but even the coarse kinds are very difficult to drive. Before inserting them they should be dipped in oil or grease. When they have been driven in sufficiently they should be snapped off flush with the surface of the wood. There is no difficulty in doing this as they are extremely brittle.

For work where it is not essential that the needle point should be particularly fine, the discarded steel points used in gramophones will be found to serve the purpose of the ordinary variety equally well. Even when obtained from the shop in the ordinary way, the price is quite inconsiderable, but as each point is used in the gramophone on one occasion only it follows that many thousands of them must be constantly thrown away.

Screws used for fastening wood together, as distinct from those used in iron-work, are known as **wood-screws**. They are made in iron, steel or brass, but in all cases the principle on which they are constructed is the same. Like nails, they consist of two parts, head and shank. A spiral thread is cut on the shaft for about two-thirds of its length in an upward direction, and a groove is sawn or filed across the head to receive the end of the screw-driver. Screws are made in all lengths from $\frac{1}{8}$ in. to 9 in., and as each size is made in various thicknesses to suit different kinds of work and different purposes, it follows that there must be several score of different sizes from which the purchaser may make his selection according to circumstances.

Round-headed screws are used for fastening the plates of bolts and rim locks to doors and for similar purposes. The under part of the head has the form of a square shoulder which, when the screw is driven home, fits flat upon the metal which is being fastened to the wood. The head rises from this flat shoulder in a semi-circular form and a groove is cut into the rounded head to receive the screw-driver. As there is little bearing for the tool, these screws should be turned with a very narrow screw-driver or a strong bradawl as with the ordinary screw-

driver the groove of the screw is liable to be damaged and broken away. Round-headed screws are generally japanned so as to be uniform in appearance with the fittings in connexion with which they are used. Brass screws of this form are also made and are used for such work as fastening brass plates to doors or other wood-work where the ordinary flat-headed screw might mar the appearance of the work.

The screws used for securing the handles of doors to the square bar or spindle by which the catch is turned are headless, the groove being cut into the flat end or top of the screw. These are known as **set-screws** and are of the form used in metal-work, having a V-shaped or bevelled thread and a blunt or rounded point.

When using screws care should be taken to first bore a hole to the depth of the unthreaded part of the shank large enough to take the shank easily. The threaded part will force its way in all soft woods; in the case of hard woods, such as oak, a hole for the threaded part should also be made with a bradawl or fine gimlet, In order that a screw may be easily withdrawn at any time when necessary, a small pot of grease or tallow should be kept and the end and part of the shank dipped into it before the screw is inserted. Screws which are about to be used should never be held in the mouth as they afterwards rust and great difficulty is then experienced in withdrawing them.

In turning a screw care should be taken to keep the screw-driver upright in order to prevent slipping and consequent damage to the head of the screw and possibly to the work. For the reception of the head a cavity should be made either with the ordinary countersink bit or the rose-bit, to which reference has already been made (see p. 63). When it is desired to sink the head below the surface of the wood, a hole large enough to take the head of the screw should first be bored to the required depth with the cent bit, and the hole for the screw may then be bored in the ordinary way. After the screw has been driven in the hole above the head should be plugged with a round piece of wood similar to that used in the work and with the grain running in the same direction. Any projecting portion may then be cleaned off so that the plug becomes unnoticeable. This process is known as **plugging** or **pelleting**.

For the purpose of cutting the holes for sinking screws in the manner above described there has been recently introduced a special **screw and plug bit** (Pl. VII). This bit can be gauged so as to give the desired depth for the screw and plug, boring

both holes in one operation. It is made in three sizes, $\frac{1}{4}$ in. $\frac{5}{16}$ in. and $\frac{3}{8}$ in. With the bit is furnished a plug-cutter to match. The knives are interchangeable, and in case one is broken can be replaced at a small cost.

In cases, where beads or mouldings held by screws have occasionally to be removed, **brass screw-cups** are used to receive the heads of the screws. A hole barely large enough both in diameter and depth to receive the cup should first be made with the centre-bit and the cup should then be forced in with a sharp blow of a hammer, a piece of metal or hard wood being interposed to prevent damage to the work, or the cup being driven below the surface of the wood. The hole for the screw can then be bored through the cup.

Bolts and nuts are sometimes required by carpenters and joiners to hold large work together as in the case of frames of bedsteads and spring-mattresses or for fastening ironwork to wood, as when fixing up large gates. They are of different forms and size and are distinguished by the form of the head and neck. The principle upon which they are made is the same in all cases. The bolt may be either cylindrical throughout its length or may finish under the head in a square neck. The head may be square, hexagonal or rounded. Bolts with square or hexagonal heads are made with round necks and they may be tightened by turning with a spanner either the head of the bolt or the nut threaded on the other end. Rounded-headed bolts with square necks can only be tightened by turning the nut.

Dowels or **dowel-pins** are short round pins made of some tough hard wood such as oak or beech and used for jointing up boards or frames. Dowel-rods or sticks from which such pins may be cut are obtainable in lengths of about 3 ft. with diameters varying from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. If the amateur is likely to use a large number of the pins it will be convenient and economical to purchase a bundle of the ready-made rods and cut off the lengths as they may be required; if he will only need them on rare occasions, he will experience no difficulty in making them himself. If it is desired to make them, pieces of straight-grained wood should be cleft and rounded roughly to the required size; pointed slightly and then driven through holes of the exact diameters in a thick steel plate made for this purpose and known as a **dowel-plate**. As a rule, the diameter of the pin should not be more than one-third of the thickness of the wood in which it is to be used, but it must in any case fit tightly into the hole bored to receive

it. The length should not be more than about 6 in. or the pin is liable to break when being driven in. In order to provide a vent for the escape of the air and superfluous glue when the dowel is forced into the hole a shallow groove should be cut down its length with either a tenon saw or V-tool. The end of the pin should be trimmed but only sufficiently to facilitate its entrance. It should on no account be rounded. These particulars with regard to dowel-pins will be sufficient to illustrate their use as alternatives to screws, nails or mere glue for the purpose of connecting pieces of wood or framework of any kind. Further details as to the manner of employing them will be given in the section of the work dealing generally with the methods adapted in making the various joints used in woodwork.

In concluding our consideration of the question of tools some mention may be made of the chests which may be obtained from dealers completely fitted with the tools generally used in carpentry and joinery. Provided that a good price is paid for such sets, and they are obtained from a reliable dealer, the outfits obtained in this way are excellent in themselves and certainly offer an attraction to the amateur who has not very definite ideas as to his requirements and who desires to be spared the trouble of working out the question for himself. They are also very suitable for presentation. On the other hand, they cannot be expected to meet the individual needs of the amateur carpenter any more than a box or indeed any collection of books chosen similarly can be expected to exactly fit the requirements of the individual reader. Apart from the fact that such collections are based upon a single conception of the general needs of the average amateur and must therefore be entirely without character, any outfit which is large enough to include all the tools which any individual worker is likely to require will also contain many which will be rarely, if ever, used. If, on the other hand, it is in any way restricted, sufficient regard cannot be paid to particular needs. On the whole, therefore, the amateur will be well advised not to purchase any ready-made collections, but to acquire at the outset only such tools as are generally regarded as essential for the ordinary operations of carpentry and to increase his stock gradually by obtaining additional tools as the requirements of the work in hand may call them into actual use.

CHAPTER IV

SHARPENING TOOLS : THE WAYS AND MEANS EMPLOYED

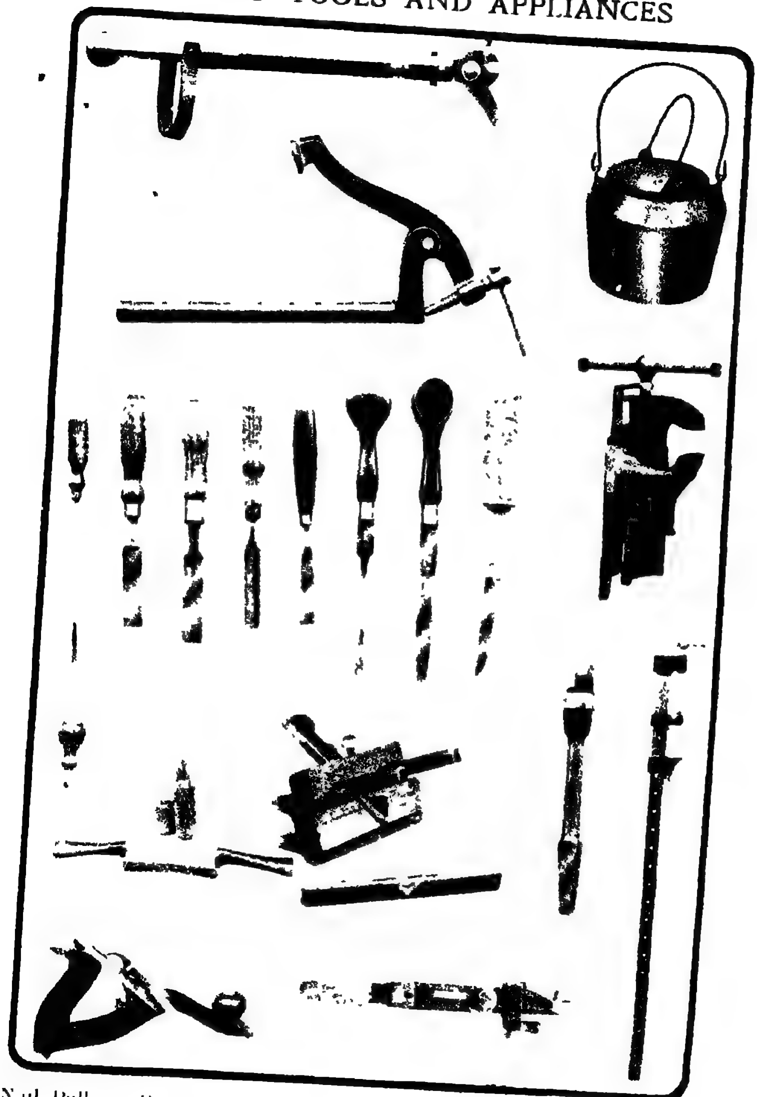
Sharp Tools a Necessity.—To do any kind of work in Carpentry and Joinery with blunt tools in a creditable and workman-like manner is simply impossible, and it is because in nine cases out of ten that the amateur neglects to sharpen his saws and edge tools when they require it, that his work is so often done with difficulty, and presents anything but a satisfactory appearance when done. The professional carpenter and joiner will frequently stop in his work to put his plane-iron and chisel on the oil-stone—for he is well aware of the importance of having a keen edge to all cutting tools of this description—and he will take care to keep his saws sharpened and fit for use. It is necessary that the amateur artisan should follow the example of the regular mechanic by keeping his tools in a fit condition to do the work required of them ; and while he is learning how to perform the various operations in carpentry and joinery and how to use his tools, he should also learn how to sharpen them when necessary.

Modes of sharpening Tools.—All *cutting tools* must be provided with a keen edge, and this is obtained by grinding them to a proper bevel on the grindstone and afterwards rubbing them on the oil-stone. Among *striking tools* the adze and hatchet will require sharpening on the grindstone, and, if necessary, a keener edge may be given by finishing off with a slip or small piece of oil-stone. All kinds of saws will require sharpening at times, and this must be effected principally by means of the saw-file. If the cutting edge of a bradawl be injured in any way it may be repaired and rendered sharp and even by filing.

With regard to the question of sharpening saws, it is possible for an amateur to get this done for him by some jobbing carpenter or by any itinerant saw-setter, who goes his regular round at intervals with his bench and files, and whose chief customers are the butchers. It is better, however, that he should learn to do the work himself than trust to another. It is far better to be independent of another's aid in all operations of this kind, for when a man can do these things for himself the necessary work can be done at any time, whereas when the services of another must be invoked, delay and inconvenience must frequently occur.

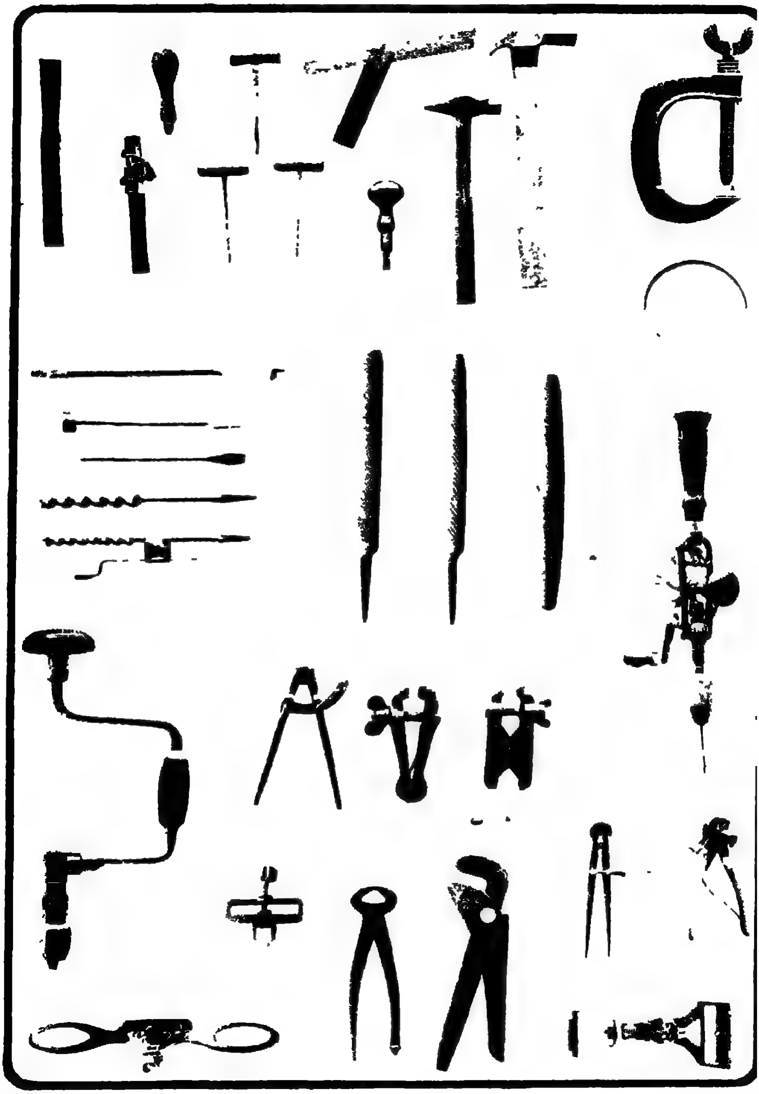
Form of Teeth of Saw.—A saw seems a very simple thing, but

Plate VII TOOLS AND APPLIANCES



Nail Puller Bench Holdfast Glue Pot Screwdrivers, Chisels and Gouges, Bradawls in sets Plough, Spokeshave Spirit Level, Plug Cutter Clamp Iron Smoothing Plane Screw and Plug Bit

Plate VIII TOOLS



Socket Chisel, Marking Knife, Marking Gauge, Bradawl, Gimlet, Sliding Bevel, Short Screwdriver, Hammer, Adjustable G Cramp, Mitre Hoop, Expansive Bit, Auger Bit, Screwdriver Bit, Boring Bit, Antifriction Bit, Depth Gauge, Rasp and File, Hand Drill, Brace, Wing Compasses, Hand Vice, Parallel Hand Vice, Tool Grinding Rest, Adjustable Spokeshave, Lancashire Pincers, Pipe Wrench, Dividers, Saw Set, Chisel and Plane Iron Grinder

it is surprising how few can sharpen and "set" a saw when it is a little out of order. If the amateur will look along the teeth of any saw used for cutting wood, that happens to be in good order, he will see that they do not lie straight, but that each tooth is bent outwards a little, either to the right or to the left, and that every other tooth is bent in the same direction. If a line be drawn from point to point on each side of the teeth, it will be seen that the space enclosed is of some widths, wider, in fact, than the sheet of metal of which the saw is made. By frequent use these points get dulled and worn away, and the space is consequently diminished, and the operator finds it a difficult matter to get the saw through the wood in consequence of the increased friction between the wood and the saw-blade. To work easily the blade of the saw should be thinner towards the back than it is at the edge, that is to say, in all kind of saws but tenon saws, in which case the back is strengthened by means of a bar of iron or brass in order to impart the necessary stiffness to the blade.

Saws should be kept greased.—When not in use the blade of the saw should be kept well greased so that it may not become rusty and consequently offer much more resistance when it is being pushed through the wood.

How to set the Teeth.—In sharpening a saw, the first thing to be done is to restore the original width between the points by bending the teeth outwards, alternate teeth being bent in contrary directions. A saw-setter will set the teeth with a peculiar kind of hammer, striking every other tooth with unerring aim and surprising celerity and then turning the saw over and repeating the operation on the remaining teeth. Great practice is of course necessary to do this with certainty, and the amateur is not recommended to attempt it as there is considerable risk of damaging the saw by knocking out the teeth.

The Saw-set; its Action.—The amateur who desires to sharpen his own saws should obtain an instrument known as a **saw-set**. In its simplest form, the saw-set consists of a broad thick blade of steel, on either side of which are cut several deep grooves of different widths. If the saw be placed in a saw-vice, or between two boards so arranged that the saw can be held tightly between them with the teeth uppermost, the teeth can be bent to the right or left, as may be required, with the saw-set; each tooth being held in turn in the groove of the proper

width and then bent by a slight pressure of the hand on the handle of the saw-set. The chief difficulty with this instrument is in regulating the depth to which the tooth is held in the groove and the pressure required. Occasionally the strain will be too great and this may result in breaking a tooth.

Patent Saw-set.—These difficulties may be obviated by the use of a patent saw-set. Several excellent forms of this appliance are now obtainable; but one of the most useful is that illustrated in Pls. VIII and XIV. In one popular form the die is rounded, fitted to the set with a screw and finished with four bevelled edges of different depths, so that it may be adjusted to set teeth of varying sizes.

Filing the Teeth of a Saw (Pl. XIV).—After the saw has been set it must be sharpened. For this purpose the blade is held in a specially constructed vice with the teeth upwards and the teeth filed with a tapered saw file at a slight angle, about 30°, from each side. It is important that this angle should be maintained throughout the length of the saw. This is, for the amateur, by far the most difficult part of the operation and before attempting the task of sharpening a good saw he will do well to obtain a certain amount of practice, either upon an old blade, the spoiling of which will be a matter of no importance or by working gently over a saw which has already been properly sharpened.

Vice for Holding Saw.—With regard to the vice in which the saw must be held while being filed, one of convenient construction is shown in Pl. XIV. Its jaws are about 9 in. long, and it is jointed near the bench, so that the jaws can be thrown backward or forward at pleasure. A very convenient saw-filer's vice with guiding attachment has been specially designed to assist those who are not skilled in the method of saw filing and will enable them to file a saw correctly even without previous experience. The amateur, who does not wish to incur expenditure on such appliances, may manage to hold his saw for the process of filing by means of his bench screw, which will be described in connexion with the carpenter's bench. All that is necessary is to place a piece of ½ in. board somewhat less in width than the saw near the handle, on each side of the saw, and then screw wood and saw tightly against the side of the bench with the bench screw. The piece of wood on the inside will keep the handle from touching the bench, if the saw be placed within the bench screw so that the handle is towards the right hand of

the operator as he tightens the screw. Saw files of different sizes should be used for different kinds of saws.

Edge Tools.—For sharpening or rather for grinding edge tools such as plane-irons and chisels, the amateur must provide himself with a good grindstone. And here the opportunity must be taken to caution him against trusting his tools to itinerant knife-grinders and tinmen, who will in all probability spoil plane-iron or chisel, and render it utterly unfit for use. The edge of the plane-iron or chisel when ground and rubbed on the oil-stone should be a straight line as true and even between its extreme points as it is possible to make it. If a plane-iron be in any other condition than this as regards its edge, it will not touch the surface of a piece of wood alike at all parts of its edge, and the result will be that the surface will be taken off somewhat deeper in some parts than others, if it be possible to work at all with a tool in such a condition.

Grindstones (Pl. XV).—Grindstones can be purchased in many different sizes, and fitted up in various ways. It is not desirable to have too small a grindstone for grinding plane-iron, chisels, etc.; the best size for the amateur is from 12 in. to 18 in. in diameter, and from 2½ in. to 3 in. in width. The commonest form of fitting up is to rest the ends of the axle of the grindstone on two parallel and horizontal bars supported on legs. The axle is prevented from jumping out of the grooves in which it is laid by iron loops or staples, and at one end it is square so as to receive the loop of a winch-handle, or handle-shaped like the letter L, by which it is turned by one person while another applies the iron to be ground to the stone. It is most likely, however, that the amateur will be alone when at work, and it will therefore be desirable for him to have a grindstone so placed that it can be turned by the foot of the operator, by means of a crank and treadle. It is a good plan to have one end of the axle made into a crank for the treadle, and the other end squared to take an ordinary winch handle, as he can then avail himself of the aid of another in turning the stone, when opportunity offers. Useful stones are made with an iron frame and trough to hold water, and of such a size that they may be placed on the carpenter's bench. These are fitted with a telescope treadle in some cases that they may be worked by the foot. Sometimes the grindstone is fitted with gear wheels, so that a considerable speed may be attained. Generally the stone is fitted with a trough in which water is kept during the operation, but as soon as the work

is done the water should be poured away, as a stone should never be left to soak in water. Care must be taken that the stone is mounted in such a manner as to run truly, otherwise it is absolutely useless. The grinding surface of the stone must also be kept level as any irregularity will render the proper grinding of tools an impossibility.

Truing Grindstones.—Special appliances for the purpose of truing a grindstone which has worn unevenly may be obtained, but they are expensive. A simple method of making the stone true is to wear it down against a bar of iron or large worn-out file held firmly down across the trough or frame in such a position that any projecting parts of the cutting surface scrape against it as the stone revolves. The stone should first be softened as much as possible by soaking it in water.

Grinding Plane-irons and Chisels (Pl. XV).—In grinding plane-irons, chisels and similar tools the stone should be turned towards the operator and the tool should be held very firmly and quite squarely upon the stone at a point sufficiently near its upper part to allow the tool to be in a nearly horizontal position, while the bevel lies flat upon it. If the tool be held too low so that its handle points downwards the water from the stone will run on the hands of the operator and, moreover, the tool cannot be held so firmly nor the progress of the work so readily observed. The edges of the stone should be kept in use by constantly traversing the tool across its face.

Patent Tool-grinding Appliances.—The amateur who experiences difficulty in properly grinding his tools in the ordinary way may simplify the operation and ensure perfect accuracy by the use of such an appliance as that shown in Pl. VIII. This rest consists of a frame, through which the chisel or plane-iron to be ground is passed, being held in position by means of a clamp screw which works through the upper part of the frame. A small wheel, placed underneath the frame, travels on the surface of the stone, enabling the user to hold steadily in one position. Any desired angle can be given by adjusting the position of the tool in the frame.

Bevels of Chisels and Plane-irons.—Plane-irons and chisels, when sent out by the manufacturers, are usually ground at the back to an angle of 25° but the bevel of the cutting edge as produced on the oil-stone is about 35°. When a tool is not held

firmly and flatly against the grindstone, the slope from the thickest part of the iron to the edge assumes a slightly convex form. When held firmly against the grindstone and properly ground the surface produced is slightly concave or hollow and corresponds to the convexity of the grindstone throughout the whole length of the bevel. Of course, the larger the grindstone the less will be this convexity. When the tool has been rubbed on the oilstone a part of this hollow surface is taken away. The work should never be hurried by grinding to a more obtuse angle than that made by the manufacturer. This is indeed sometimes more obtuse than it should be, and carpenters reduce this angle and then the second bevel formed by the oil-stone restores it correctly. In grinding planes and chisels, especially the former, it is well for the amateur to make use of a square to test the correctness of the edge as otherwise it may not be truly at right angles to the side of the tool.

Gouges.—In grinding gouges care must be taken to ensure that the bevel follows the curve of the tool. The tool should therefore be held at right angles to the stone, i.e. in the same direction as the axle and rolled forwards and backwards as the operation proceeds (see Pl. XV).

Grinding Axe or Adze.—When sharpening an axe or an adze, the tool should be traversed across the face of the grindstone until the notches have been taken out and the edge is clean and clear from one point to another (see Pl. XV). If it is desired that the edge should be very keen it must be finished off by rubbing with a slip of stone.

The Oil-stone and How to use it.—The oil-stone is constantly needed during all operations in carpentry and joinery in which the the plane and the chisel is called into use. It is, indeed, wanted far more frequently than the grindstone, for this is only necessary when the edge of the tool is altogether too dull to be sharpened by the oil-stone. There are two things to be taken into consideration here, namely, the nature of the oil-stone and the manner of using it, or rather, of applying the iron to it. The stone should be set in a piece of wood so that its surface is perfectly level, and over it a loose cover is fitted, made of the same kind of wood, which preserves it from dust and injury when out of use.

Size of Oil-stones.—The most serviceable sized oil-stone for

the amateur is one about 2 in. wide and 8 in. or 9 in. long, and if one can be procured that is a little wider it should be taken in preference to a narrower one. A stone should be neither too hard nor too soft, as a soft stone will soon wear, while a hard stone grinds slowly, and through the iron not biting fairly on its surface, some time is taken in putting a good edge to it, that is to say, an edge of the necessary fineness, smoothness, and keenness. Sometimes, too, a stone is met with which has a hard spot in it, over which the tool slips, and as the rest of the stone wears away the hard spot rises slightly above the level of the other part. On such a stone as this it is impossible to sharpen a tool properly.

Selecting Oil-stone.—Turkey stones are considered to be the best, and they are so undoubtedly when they are really good, but a good Turkey stone is very expensive. Next to these in quality are the Arkansas stones. It has a perfectly smooth surface is of very hard substance and grips well. It is probably the best stone for very fine edge tools, but like the Turkey variety is high priced. This is due to the expense of cutting. Washita stones, another variety of American oil-stones, are also very good. Of other stones of this description the Charnley Forest oil-stone is as good if not superior to any others. It may be known by its green slate colour. Probably the most useful oil-stones for the purposes of the amateur are the recently introduced India oil-stones. They are manufactured of pure corundum, and are made in three grades—fine, medium and coarse. The fine stone is fast cutting and close grained, leaving a smooth, clean edge on the hardest and finest of steel tools, with results similar to those obtained from the ordinary grade of Arkansas stones. The grades are also obtainable in combination, one face of the stone being medium, and the other face coarse grade. These combinations are very convenient, as the coarse side can be used for sharpening dull tools or where fast work is desired without regard to fine finish, and the medium side when a finer edge is required or for finishing, after the coarse side has been used.

Substitute for Oil-stone.—A very efficient substitute for an oil-stone is often made by carpenters by mounting a strip of zinc about 8 in. in length and 3 in. in width on a suitable piece of wood and giving it an abrading surface by sprinkling on it a mixture of flour of emery and oil. In fastening the zinc to the

wood the metal is bent over the ends of the wood and nailed or screwed lengthways with the grain, so in the operation of sharpening the whole of the surface is available. The cutting action of this " stone " is very rapid, but the edge produced is not so fine and smooth as that obtained by the use of a good oil-stone of the ordinary kind.

Oil-stone Slips.—For sharpening the hollow sides of gouges and similarly shaped tools slips of oil-stones are obtainable in shapes and sizes suitable for the curve of the edge of the tool. Illustrations of the form commonly used are given in Pl. XVI. For general use, however, the amateur who uses such tools to any considerable extent may obtain an emery slip-stone with a large variety of curves along its edges which render it suitable for all sizes of tools with either inside or outside bevel.

Lubricants for Oil-stones.—Various kinds of oil are recommended for use with oil-stones, but as a general rule it will be sufficient to bear in mind that the oil should not be of a gummy or clogging nature, as in the case of linseed oil, for this will in time harden on the stone and produce a glazed surface which will be without bite or grip and therefore useless for wearing away the steel of the tool. Paraffin and other mineral oils harden the stone itself and should also be avoided. The oils most generally recommended are neats-foot and olive or sweet oil. Some workmen prefer to dilute these oils with a small proportion of paraffin, and on quick-cutting stones this mixture is doubtless an improvement on the oil alone.

Cleaning Oil-Stone.—Great care should be taken that no foreign gritty matter or workshop dirt of any kind accumulates on the face of the oil-stone. To obviate this, the cover of the box should invariably be kept on the stone when the stone is not in use. If put aside for any length of time the stone should be first thoroughly cleaned with a piece of cotton waste or soft rag.

Hardened Oil Stones.—If in spite of care in the selection of lubricants the surface of the stone should become hardened, the trouble may sometimes be remedied by washing the stone with a little paraffin or turps or by boiling it in soda water. When paraffin or turps is used the stone should be wiped dry immediately after being cleaned. If the methods given above fail to restore the cutting quality of the stone, the surface should be

cleaned off by rubbing the stone on a piece of emery cloth laid on a flat board or by holding it against the side of a revolving grindstone.

Method of Sharpening Tools on Oil-stone.—The great difficulty which the amateur will experience in setting a tool on the oil-stone lies in keeping the bevel at the same angle with the stone throughout the operation. As he moves the tool backwards and forwards along the stone, he is apt to give it a different inclination when close to him than when at a greater distance, the angle at which the tool is inclined being greater when in the former position than in the latter. In order to counteract this variation of angle it is evident that the tendency to be aimed at is the raising of the hand slightly as the tool moves further from the person instead of allowing it to take different angles of inclination during its movement over the stone. The elbows should be squared, and the hands and arms should have freedom. The tool should be grasped with the right hand so that the first finger only is held above. The fingers of the left hand should lie together and straight upon the upper side, their tips fairly near the edge of the tool, the thumb being underneath. The tool will thus be held firmly and well under control. (See Pl. XIV, Fig. 5).

Mechanical Aids in Sharpening Tools.—The amateur should not be disheartened if, for some little time, he should fail to obtain a sharply defined bevel, and a good cutting edge upon his chisels and plane-irons. Although the sharpening of edge-tools is generally acknowledged to be a difficult matter for beginners there is no actual reason why the proper method should not be acquired. If, however, in spite of carefully following the instruction given above, after some practice he is still unable to obtain satisfactory results he may desire rather than send his tools to a professional man to obtain one of the many excellent contrivances which have of late years been introduced to help him in this respect. In Pl. VIII is shown an invention for holding chisels and plane-irons while sharpening them either on the oil-stone or grindstone. When the tool is put into the holder and brought to the right bevel with the adjusting screw it is a simple matter to bear it on the stone and by moving it forwards and backwards to obtain a perfectly uniform bevel and a keen edge. This appliance is sold at a very moderate price, but the amateur, with the exercise of a little ingenuity, should have no difficulty

in making of hard wood a similar appliance which would serve its purpose quite well until he has learned to manage without its assistance.

Levelling the Oil-stone.—When sharpening plane-irons and chisels, the strokes should be made as nearly the full length of the stone as possible in order that the wear may be even over the whole of the surface. If only the middle of the stone be used a hollow will be formed and the edge of the tool will obviously correspond in shape. After a great deal of use this must happen to the stone in any case, but as soon as any concavity becomes apparent the level of the surface should be restored by rubbing it down on a piece of emery cloth tacked to a board or with a mixture of fine sand and water on a piece of plate glass.

Wire-edge on Plane-Irons and Chisels.—After a tool has been sharpened on the oil-stone in the manner described, a small portion of steel known as a wire-edge will often remain upon the tool, although the edge of the iron itself may be perfectly keen. To remove this wire edge, the tool should be laid flat on its face and in this position rubbed lightly on the stone. (Pl. XIV, Fig. 6.) It should then be finished off with a few strokes on a piece of buff leather (Pl. XVI, Fig. 3). The practice of workmen in using the palm of the hand for the purpose is not to be recommended to the amateur, although it is quite safe when done slowly and carefully.

Testing the Edge of Tools.—Carpenters may often be seen to test the sharpness of tools by drawing the thumb gently along the edge. For the amateur, however, the better method is to examine the edge by holding it up in a good light. If the tool has been properly sharpened, the edge will be quite invisible; if a fine shining line appears a perfect edge has not been produced and the operation of sharpening should be continued.

Sharpening Gouges.—After being ground to the proper shape, gouges are finished on the oil-stone, on the outside by giving it a rolling motion as, being held at right angles to the length of the stone, it is moved forwards and backwards on the surface, and on the inside by rubbing them with a suitably shaped slip of oil-stone (as shown in Pl. XIV, Fig. 4 and Pl. XVI, Fig. 5 respectively).

The Spokeshave.—Spokeshaves may be sharpened by removing the blade from the stock and rubbing it on the inside with a flat

slip of oil-stone (Pl. XVI, Fig. 6), and lightly rubbing the outside on the ordinary oil-stone. If any difficulty is experienced in holding the small iron, it may be fixed into a saw-kerf made across the end of a small flat piece of wood with the edge of the blade projecting beyond the wood, which should be bevelled off so as to allow the iron to lie fairly flat on the stone. It may then be sharpened like a plane-iron.

Scrapers.—When the scraper ceases to take off shavings of uniform thickness it should be sharpened. To ensure that all irregularities in the cutting edge are removed the steel should be first placed in the bench vice and the edge trued up with a smooth file and finished with a flat slip of oil-stone. If desired, the edge may be slightly rounded from end to end. It should, however, always be square across. In order to remove any wire edge and leave the edge of the scraper perfectly square it should then be laid flat on the oil-stone and rubbed lightly forwards and backwards, as when removing the wire edge from a plane-iron or chisel (see Pl. XIV, Fig. 6). After this operation, the scraper should be laid on the bench and with a burnisher or other smooth piece of steel such as the back of a gouge the arrises or edges should be drawn up in the manner shown in Pl. XVI, Fig. 1. Finally the scraper should be held firmly on the bench and the arrises should be forced down by passing the burnisher lightly but with even pressure once or twice along the edge in the manner shown in Pl. XVI, Fig. 2. The angle at which the burnisher is held and the burr is formed with reference to the surface of the scraper will determine the angle at which the scraper is to be held when in use.

Gimlets.—In order to sharpen a gimlet, a hole should be made with the tool itself in a piece of hard wood, such as oak, to the depth of about one inch. After withdrawing the gimlet the hole should be filled with a mixture of fine emery and oil. The gimlet should then be again inserted and when screwed down about another half inch should be turned vigorously forwards and backwards until perfect cutting edges have been formed. From time to time during this operation fresh emery and oil should be added. A fine polish may afterwards be given to the gimlet by repeating the operation, but using a piece of soft wood and filling the hole with dry flour emery or brick dust.

Bradawls.—These may be sharpened with a smooth file and afterwards finished on the oil-stone.

Boring-bits.—The ordinary centre-bit, if treated with care, rarely requires sharpening. When necessary, the horizontal cutter should be sharpened with a file in the manner shown in Pl. XIV, Fig. 1; the vertical cutter must be sharpened on the inside only. A smooth file should be used and the cutting edges finished off with a slip of oil-stone. Other boring bits of ordinary patterns should be treated similarly.

Forstner-bits.—The special method of sharpening these bits (see p. 64) recommended by the makers is as follows. Take a hard three-cornered file and grind smooth at the front end, thus making a three-cornered scraper. Scrape the inside of the flange until sharp and take off the outside wire edge with a piece of oil-stone. Then file the cutters with a small fine-cut file. For very smooth work take the edge off so as to form a very slight bevel on the outside edge of the flange, always being careful to have the flange project a little beyond the cutters. In the case of the bit being too hard, heat a pair of tongs and take hold of the shank at the back of and close to the flange and draw the temper to a light blue colour. Then cool in water and the bit can be easily filed and scraped.

Screw-drivers.—The end of the screw-driver blade should not be sharp, as chipping, both of the tool and of the head of the screw, is in this case likely to occur. If, on the other hand, it is too blunt or the angle of the bevel to which it has been ground is too obtuse it will not seat itself properly in the slot in the head of the screw and under the strain of turning may slip and damage the work. In order to form a proper edge to the screw-driver, the end of the blade should be placed on the grindstone in the position and at the angle shown in Pl. XV, Fig. 2. When ground in this way it will enter the head of the screw and grip the bottom of the slot and at the same time will have little play or tendency to slip when it is turned.

Tools, To remove Rust from.—The amateur's tools may sometimes be allowed to get rusty by being left for a short time in the rain when working out of doors, or the dampness of the shed or workshop in which he carries on his operations may produce the same result. The latter cause is a very common source of rust in tools, and even if the shed be perfectly water-tight the dampness in the air itself during prolonged rain and wet seasons will frequently do much mischief. The

following is a simple method of removing rust from steel which will be found useful :—

Cover the metal with sweet-oil well rubbed in. Allow to stand for forty-eight hours, and then rub with unslacked lime reduced to as fine a powder as possible.

Another method is to immerse the article to be cleaned for a few minutes in a strong solution of cyanide of potassium, say about half an ounce in two ounces of water; take out and clean it with a tooth-brush with some paste composed of cyanide of potassium, Castile soap, whitening, and water; the paste should be about the consistence of thick cream.

Rust Preventives.—Prevention, however, will be deemed by many far better than the cure, and when tools have to be left in a shed or workshop without any means of warming it throughout the winter months, when they are seldom used, it may be profitable to subject them to some such treatment as the following :—

1. Boiled linseed oil will keep polished tools from rusting, if it is allowed to dry on them. Common sperm oil will prevent them from rusting for a short period. A coat of copal varnish is frequently applied to polished tools exposed to the weather. Woollen materials are the best for wrappers for metals. 2. Iron and steel goods of all descriptions are kept free from rust by the following :—Dissolve ½ oz. of camphor in 1 lb. of hog's lard, take off the scum and mix as much black lead as will give the mixture an iron colour. Iron and steel and machinery of all kinds rubbed over with this mixture and left with it on for twenty-four hours and then rubbed with a linen cloth, will keep clean for months.

In applying the boiled linseed oil care should be taken that the metal is clean and bright. The oil should be warmed and the linen pad with which it is applied should be thoroughly dried by heating it. The oil should then be allowed to dry without handling and, to make sure, a second coat should be given. Boiled oil gives the metal a gun-metal tone, but this is no disadvantage.

Another good varnish for the prevention of rust may be made as follows :—

Ingredients :—Resin, 120 parts; sandarac, 180; gum lac, 60; essence of turpentine, 120. Take the first three of these ingredients in a pulverized form and digest them by regular heat till melted. Then add the turpentine very gradually,

stirring all the time. The mixture should be digested until thoroughly dissolved, when rectified spirit, 180 parts, should be added. It should then be filtered through fine cloth or blotting paper and preserved in well-stoppered bottles or jars.

CHAPTER V

JOINING WOODWORK

Joining Woodwork.—Having provided himself with tools, and having learnt in some measure how to handle them and how to use them, the next thing to which the amateur artisan must turn his attention is the consideration of the various methods employed in joining timber and pieces of wood together. But before attempting any of these operations, though they may be said to be operations that are performed every day in carpentry and joinery, it is absolutely necessary to be able to saw and plane wood in an efficient manner—to saw truly and straightly in the proper direction, and to plane up the surface and the edges of a piece of wood in a workmanlike manner.

Planing, Operation of.—The operation of planing has been already dwelt on to some extent, but the importance of rendering perfectly true and square by this means the pieces of wood which are afterwards to be joined together can hardly be over estimated. One of the first, and perhaps the most frequent, of wood-working operations, is that of planing a piece of rough wood down to a certain size and thickness. Indeed, whatever joint the amateur wishes to make, he must first plane the different pieces to the right thickness and shape. Nothing but operations in rough carpentry, such as framing pieces of timber together, can be done without the aid of the plane; in joinery nothing whatever can be done without it. For this reason it will be an advantage to the amateur to give further details of the actual process

For the sake of clearer and easier explanation, let us suppose that a piece of wood, square in shape, is wanted with sides of twelve inches each way, and one inch in thickness. The piece of wood which is to be worked into the above dimensions must be rather larger every way, and should be sawn off from the most convenient piece in the amateur's possession.

Allusion has been made once or twice to the carpenter's bench, but this will be described in the following chapter, and

instructions given for making this, and also the stools or trestles that are so necessary when sawing timber or mortising. The uses of the parts of the bench, of which mention must necessarily be made in the following description of planing, will be readily understood. Having sawn off the piece of timber, lay it on the bench just as it is, in the rough, with one side bearing against the bench stop—generally a piece of wood fitted tightly to a square hole in the bench, and which can be depressed till it is level with the surface, or raised by a few blows from a hammer until it stands above it at a height sufficient for the purpose required. In this case it may be about ⅜ in. above the surface of the bench, and therefore rather more than ½ in. below the upper surface of the wood that is about to be planed. If it project in the least degree above the surface of the wood to be planed, it will inflict serious damage on the cutter of the plane.

Whenever possible—and this is generally the case—the wood must be planed *in the direction of the grain* (see p. 51; it is not only much easier, but a much better surface is obtainable. The bulk of what has to come off must be taken off with the jack-plane. Take hold of the handle with the right hand, put the left on and over the plane, just in front of the escapement or clearance hole, lay the plane flat on the wood and push it forwards, pressing hard with the left hand at the beginning, and with the right hand at the end of the stroke; bring it back and again send it forward by firm, even strokes, taking great care to keep the plane always parallel to the surface of the wood and to avoid letting the ends drop at the commencement and termination of the strokes. This is a very common fault with beginners, but unless it is overcome the surface will never be flat or, as it is generally termed, "true." The necessity of guarding against this tendency cannot be too strongly impressed upon the mind of the amateur because it is much easier to acquire the proper method at the commencement than to get out of bad habits when once acquired.

Plane-iron, Adjustment of.—If when the plane is passed over the wood no shaving comes off a slight tap with the hammer on the front end of the stock will generally be found sufficient to cause the cutting iron to project the required distance beyond the sole, but if this method fails a very gentle blow should be given on the top of the iron itself. Care should be taken to strike in the middle of the iron or one corner will project farther than the other. If this should happen, the iron may often be set square by striking it at the top on the same side as the corner which is

out. If the iron is made to project too far it will cause the plane to chatter and to work hard, or, as carpenters sometimes say, "too rough." To remedy this the stock should be tapped smartly behind; one or two blows will bring out not only the planing-iron, but the wedge also. They should then be re-adjusted. Having finally adjusted the iron, the wedge should be firmly driven in, but not to such an extent that it cannot easily be loosened or removed. Any excessive force will result in the plane being damaged or even split. When the plane is properly set the operator will be able without any violent exertions to pass the plane smoothly over the wood, taking off at each forward stroke clean shavings of even thickness and the planed surface will be smooth and level.

Testing Planed Surface.—When one side of the wood is planed it should be tested for hollowness or roundness by laying one of the lower edges of the plane across the wood, when any such defects will be noticeable on account of the light passing between the plane and the board. In order to detect any twist or "wind" in the surface it is necessary to apply two perfectly parallel strips of wood known as "winding sticks." These are usually about 16 in. long, 2 in. wide, ½ in. thick at the bottom, 1 and ½ in. at the top. They are placed parallel to each other at the respective ends of the board, as shown in Pl. XII, Fig. 2. If when the head of the worker is lowered, so that the eye is level with the top edge of the nearest stick, that edge lies exactly parallel with the more distant one the board is known to be "out of winding"; any inaccuracy is easily observable as it is apparently increased by the length of the sticks being greater than the width of the board. If any defect of this sort exists it must be remedied first by planing the board diagonally and afterwards by going over it again lengthways. When one side of the board is found to be correct it is termed "faced" and should be marked with a pencil "face mark" near to one of the edges.

Planing to Proper Thickness.—When one side of the wood has thus been trued, the marking gauge should be set at 1 in., and a line struck along each of the four edges of the board. It should then be laid on the bench with the planed side downwards and planed *nearly* down to the line just struck. When both sides have been smoothed off with the smoothing plane the board will be the exact thickness required.

"Squaring" the [illegible].—In order that the wood may be "squared" it should be fixed in the bench vice and one edge planed at right angles to the "faced" surface and tested with the square in the manner shown in Pl. XII, Fig. 1. Using the square, two lines, twelve inches apart, should then be marked off across the board at right angles to the edge already planed. If the end of the board is very much out of the square, cut off most of the superfluous wood with the tenon-saw and finish with the plane as before. In planing the sides in which the end of the grain appears, plane down to the line at one corner first, then plane down the other corner and then the middle. If this precaution is not taken, the corners are liable to "spawl" off and present a ragged and unseemly appearance.

If the amateur can, in a creditable manner, get through the work above described he will be able to do anything which may be required in the way of planing and attention may now be turned to the jointing up of the prepared material.

Joints.—For convenience of reference, joints may be divided into four classes: (1) edge joints, for uniting the edges of boards; (2) angle joints for connecting the edges of boards or ends of frames at various angles; (3) framing joints, used only for framework; and (4) miscellaneous joints for special purposes.

Edge-joints.—These are sub-divided into *glued joints* and *dry joints*. The simplest form of joint which it is possible to make is the square or plain glued joint (Pl. C, Fig. 1). The process of joining the edges of boards together so as to make a wider surface is often termed "butting." In this case the edges are merely planed perfectly true and square and then joined with glue. When placed edge to edge and tested for accuracy, not only should the two boards be in contact throughout their whole length, but their surfaces should lie quite level and show no inclination to form an angle at the joint. When a perfect fit has been obtained the edges should be brushed over with hot glue and, before the glue has time to set, well rubbed together so as to force out any surplus. If possible the edges should be warmed before the glue is applied. When the boards have been fixed together in this way they should be placed in the cramps with a strip of waste wood on each side to protect the edges and screwed up tightly. About twenty-four hours should be allowed for the glue to set and harden, but the actual time required depends largely on circumstances, such as the warmth and dryness

Plate E. MITRE JOINTS, etc.

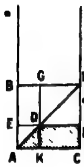


Fig 1

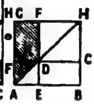


Fig 2

Fig 3

Fig 4

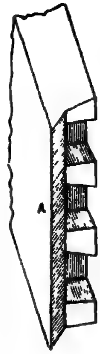


Fig 5

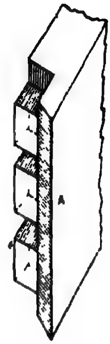


Fig 6

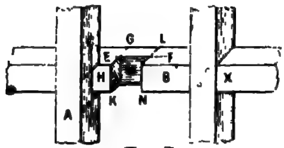


Fig 7

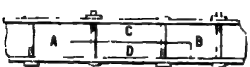


Fig 8

Fig 9

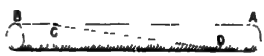


Fig 10

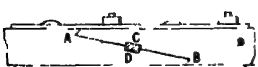


Fig 11

Fig 12

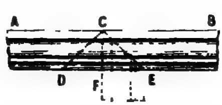
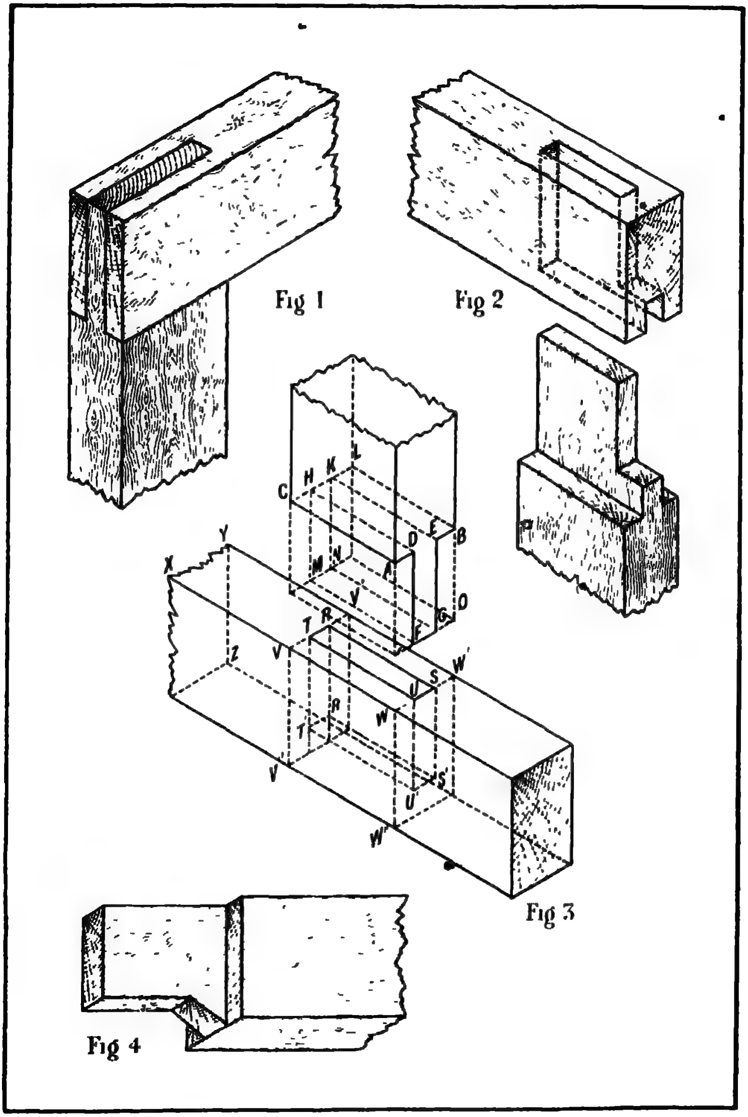


Fig 13

(1-6) Mitre dove-tail joint ; (7) Halving joints (8-12) Scarfing joints, (13) Mitre-joint

Plate F. FRAMING JOINTS.



(1) Open mortise and tenon, (2 and 4) Haunched tenon, (3) Mortis and tenon

of the room and the quality of the glue. It is often said that a plain glued joint when properly made is stronger than the wood itself and in the case of soft woods this is certainly correct.

Ploughed and Tongued Joints.—Another method of joining the edges of boards which presents no great difficulty if the amateur possesses a grooving plane or "plough" and which, owing to the greater surface of wood to be glued, is much stronger than the plain square joint, is shown in Pl. C, Fig. 2. After the edges of the board have been planed true, a groove, which must never be more than one-third the thickness of the boards to be joined, and which is generally less, is then cut in the middle of both edges with a grooving-plane or plough. The tongue which is to be pressed into the grooves to hold the boards together must next be planed to the proper dimensions, and when it is ready, should be coated with glue, and inserted into the grooves, the edges of the board being brought close together by means of a clamp, or pair of clamps, and held tightly till the glue is dry. Tongues may be made with the grain running in the same direction as the boards or transversely (Fig. 3); the grain may also cross the tongue diagonally (Fig. 4). These varieties are known as *slip*, *cross* and *feather* tongues respectively. Cross tongues are the strongest, but as they are more difficult to make it is doubtful whether the balance of advantage is in their favour.

Planing Slip and Laths.—Whenever the amateur artisan has occasion to plane down a long slip for tongue, or anything long and slender, and consequently weak, instead of placing the wood against the bench stop, and planing towards it—in which position the first stroke of the plane would snap the wood—he should nail, or otherwise fasten, the extremity of the slip nearest to him, to the bench, and plane *from* it. Whatever may be the length, it will then be easily accomplished. The amateur artisan should adopt this plan in planing any piece of thin, narrow wood, as laths for trellis-work.

Matched or Tongued Joints (Pl. C, Fig. 5) are similar to the above, but the tongue is formed on the edge of one of the pieces of wood to be joined. After the edges of the two boards have been planed true, a groove one-third of their thickness, and sometimes a little less, is cut in one piece by means of the grooving iron of a match plane, while with the aid of the tonguing iron a tongue is cut in the other. This tongue should completely fill the groove,

but should not fit so tightly that it cannot readily be pulled out with the hand. An exemplification of this mode of joining boards is to be found in match-boarding (Figs. 6 and 7). It is used chiefly when a large surface has to be covered with boards, and it is necessary to connect their edges in such a way that the edge of one may hold down and retain in its place the edge of that which has been placed in position just before it. Match joints are only used for joining thin wood. The special planes must be kept in good order as, if the corner of the cutters forming the tongue become at all rounded, it is impossible to make a close joint.

Dowelled Joints (Pl. C, Fig. 8).—In place of tongues, dowel pins (see p. 94) are often used to strengthen glued joints. The amateur will find this method useful in many ways. An exemplification of it may be found in the joining of the leaves of a dining-table, by small wooden pegs which project from the edge of one leaf at right angles, and fit with great accuracy and nicety into holes made for their reception in the edge of the leaf that is placed next to it. In dowel jointing the pins may be inserted either perpendicularly to the surface of the work, or, with a view to greater strength, they may be placed in an inclined direction, but in either case if more than one be used in any particular joint the pins must be perfectly parallel. In jointing two boards in this manner, the boards should be placed back to back so that the edges exactly coincide and, with the aid of the square, lines should be drawn across the edges 8 in. or 12 in. apart. The gauge should then be set to exactly half the thickness of the wood and, from the face side of each board, lines should be drawn across those made at right angles to the edges. At the intersection of these lines, holes for the dowel-pins should be bored with a twist bit to the required depth, and perfectly square with the edge. The angle at which the hole has been made in the first board should be tested and any necessary correction made by inserting the pin and, after placing the two boards with their edges quite parallel, marking the direction of its axis across the face of the other board. In order to remove any burr which might prevent a close fit, the holes may be very slightly countersunk. Before finally inserting the pins, glue should be applied with a small stiff brush to the inside of the holes. As soon as all the pins have been inserted in one side, the projecting ends should be cut to the exact length required and the edges trimmed off. The second set of holes and also the edges of the two boards should then be glued and the whole

fitted together and securely clamped. Three points which the amateur when making such a dowel joint as that described will do well to remember are (1) the edges of the boards should be shot perfectly straight; (2) the ends of the pins projecting from the edge of the first board should not be too long for the holes bored in the second board for their reception; and (3) no superfluous glue must be allowed during the process to set around the first set of holes in such a way as to prevent the edges of the two boards from being pressed close together. If possible the glued edges should be well heated just before the final heating.

Dowel jointing is generally regarded as a method of joining frame-work to be adopted only when the ordinary tongue-joint, which is commonly supposed to be much stronger, would be out of place or unsightly. It may be mentioned, however, that in recent years this method has been adopted in connexion with the manufacture of furniture to an extent which is little realized by the ordinary joiner and cabinet-maker. In many of the large factories established in the East End of London, where foreign workmen are employed and time is an all important consideration, the process would, in fact, appear to have almost entirely replaced what is considered the old-fashioned method of the English workman. In addition to the great saving of time effected, it is claimed that properly made dowel-joints are at least equal in strength to the mortise and tenon, that the method may be applied to almost every variety of work, and that it has the further advantage of making a practically invisible joint.

Dry Edge Joints are used chiefly for connecting the edges of flooring and matchboarding.

Ploughed and Tongued dry joints are similar to those described under this heading above, but the tongue fits loosely in the groove and merely serves the purpose of holding the boards in their relative positions and of preventing dust or draught from passing through the joint when the boards shrink. In Pl. C, Fig. 9 is shown a section of boards connected in this way with the tongue made of wood. In some cases a thin iron tongue is used, as illustrated in Fig. 10. This gives a greater depth of wearing surface.

Filleted Joints are formed by laying a loose tongue or fillet in a rebate formed on the back of the boards. They are used in the case of exceptionally thick flooring. The advantage of this

form of joint is that any single board can be removed without disturbing others. The fillet is much thicker than the ordinary tongue.

Rebated Joints are formed by overlapping the rebated edges of the two boards to be joined, the step or half cut from one being exactly filled up, the half or projecting part left in the other. This joint is a variation of the filleted joint, the fillet being formed from the solid of one of the boards.

There are several other forms of edge joints, such as *dove-tail grooving joints, bevel tongue* and *lip joints* for secret fixing, i.e. without visible nails, Pl C, Figs. 11, 12, 13 and 14, but as these will rarely, if ever, be used by the amateur it is not necessary to further describe them.

Angle Joints.— The two methods generally adopted in joining boards at right angles are called *keying* and *dove-tailing*.

Butt or Square Joint.—A further simple method which may be useful to the amateur and which may first be described, is that which is commonly adopted for nailing together packing cases. In Pl. D, Fig. 1, is shown the way in which this is done. The edge of one board is brought against the inner surface of another, and nails are driven through the former into the latter to fasten the boards together. The joint is a weak one, and a very little force will serve to disconnect the boards; but when four boards are nailed together in this way, as the four sides of a box or packing-case, one corner strengthens another, and when the bottom is nailed on, it is difficult to wrench the boards asunder.

Rebated Joint (Pl. D, Figs. 2 and 7).—When wood of some thickness is used, as in making a small frame for the reception of plants, a shallow rebate may be cut at each end of the sides, affording a slight shoulder against which the boards, which form the top and bottom of the frame, can be lodged previous to nailing the whole together.

Keying.—One of the most useful and most frequently required joints in joinery, is that which is used to unite two pieces of wood to each other at right angles. For very light work, and where strength is of secondary importance, the method shown in Pl. D, Fig. 3, and termed "keying" is generally used. The edges are bevelled or mitred away each to half the required angle. The

bevelled edges are glued together and when dry three or four cuts are made with a fine saw diagonally across the joint. Thin pieces of wood of such a thickness that they fit tightly into these saw-cuts are then coated with glue and forced into place. When dry they are cut off level with the surface. If done well this makes a very neat joint, the saw-cuts being hardly observable. When greater strength is required the dove-tailed form of key shown in the same illustration and in Fig. 4. may be used. Another method of keying is shown in Fig. 5.

Corner-piecing.—In this method the edges are mitred together as in that last mentioned, but when glued together, instead of using slips of wood inserted into saw-cuts to keep them together, a corner piece is made to fit and glued or screwed on inside (Pl. D, Fig. 6). The joint is very simple and neat, but it is not very strong. It is often used for joining the corners of workboxes and for similar purposes. In workboxes the corner pieces, if not carried up the whole length of the joint will serve as a support for the tray.

Dove-tail Joints.—Of this joint there are four kinds; the common or single dove-tail, the compound dove-tail, the dove-tail for drawer fronts and the mitre dove-tail. Although it will be necessary to mention the peculiarities of these in turn, it is needless to describe in detail more than the construction of the single or common dove-tail in detail, for one and the same principle of construction characterizes the whole set, and is followed in them all.

Common Dove-tail Joint (Pl. D).—When appearance is of little consequence and strength of the utmost importance, the common dove-tail joint should be used. In the illustration, Fig. 10 shows the pin, as it is called, and Fig. 9 the socket of a single dove-tail. Very few workmen follow any arbitrary rule as to the proportions and shape of the different parts; they go by their judgment and their eye, and if they have had any experience they are seldom wrong. To the amateur, who cannot be expected to have had much, if any, practice, the following hints will be of material assistance. If he works according to rule when he commences, practice will soon make him familiar with the proportions, and render any measurement or rule unnecessary. This does not of course do away with the necessity that exists for marking the depth of the pin and socket with the marking-gauge. This must be done even by the best of workmen. Hard

and tough wood will admit of a more acute angle than soft wood, or wood that is subject to split or chip.

Method of Marking out:—Dimensions of Pin and Socket, (Pl. D, Fig. 10).—Let us take the pin and socket shown in the above illustration as an example. It is, as it has been said, the pin and socket of a single dove-tail, but the same rule is followed in the construction of all. Having determined the depth of the pin, which will be governed by the thickness of the board in which the socket is to be cut, into which the pin is to be fitted, set the head of the marking-gauge to the required distance from the point; and, holding it against the end of the wood, mark on its four sides in succession the lines E C, C K (Fig. 10), and the lines opposite to them from E and K on the sides that are not shown in the drawing. Next divide E C into three equal parts in the points D and B, D B being the central third, that is, the root or bottom of the pin. Draw two lines, B A and D F, at an angle of 70° or 80° to C B and E D, respectively. Draw two other straight lines, A H, F G, at right angles to F A. Perform the same operation on the side of the wood which is hidden from view; that is to say, trisect the line from K to the corner formed by the meeting of the lines K and E, and join the points on either side of the central third, to G and H respectively, one of these being H I, which is shewn in the diagram. The amateur will find it good practice to copy the diagram on a larger scale, completing the parts cut away on each side of the pin with dotted lines. This will materially assist him when he is putting the directions given into practice in wood. Assuming that these lines have been marked on the wood, the operator should lay the tenon saw upon the line C K and cut across the grain till it comes to B I. Lay the saw next upon A H and saw in a direction very nearly corresponding to that of the grain until B I has been reached and a junction effected with the saw-cut first made through C K. Remove the piece of wood thus detached and proceed in the same manner on the other side. If a smooth cut has been made, nothing further is required to be done to the pin; but, if roughly sawn or the two saw-cuts do not meet and the piece nearly cut off is torn away, any projections that are left must be cut away with a chisel. Having finished the pin, it now remains to cut the socket for its reception. First, lay the pin upon the end of the piece intended for the socket, that is to say, on the end shown uppermost in Fig. 9, and with a sharp pencil mark on the end of the shape of the pin. The lines thus marked would be those shown as A B and C D in Fig. 9, the part between B and D receiving the narrow part

or throat of the pin, and that between A and C the wide end, namely the parts lettered respectively D B and A F in Fig. 10. Saw down to the required depth shown by the line E F. This depth is equal to the thickness of the wood from C to K in Fig. 10 and straight lines should be previously marked all round at this depth with the square. When the saw-cuts have been made through A B and C D to the necessary depth, the central piece must be removed with a chisel. The piece removed, if it could be taken away without breaking it, should be exactly the shape of the pin and slightly smaller because the pin has to replace it and it is necessary that the pin should fit fairly tight into the opening cut for its reception. When glued together, the pin and socket present the appearance shown in Fig. 8, in which the single dove-tail is represented in a finished state.

The Compound Dove-tail.—The only difference between this and the single dove-tail is that the latter has but one pin and this has three or more.

When the wood has been planed to the proper size and the sides or edges squared, a line should be struck by means of the marking gauge along the pin part on both sides. The distance of this line from the edge should be rather more than the thickness of the socket part. The pins are cut out as in the single dove-tail, the parts between the pins being removed with the chisel Lines are then marked on the flat side of the socket part, the thickness of the pin being their distance from the edge of the board. The shape and position of the sockets can easily be found by laying the pins upon the edge of the socket and marking them off with a sharp pencil. The sockets are cut out in the same manner as in a single dove-tail. If the pieces of waste wood to be removed are at all large, a few steady blows should be given with a mallet upon the chisel handle. No attempt should be made to take out the whole of the wood at one cut, but a part should be taken out at a time and when the wood is nearly removed the chisel should be held somewhat out of the perpendicular so as to cut in under and insure a tight and neat joint when put together. In this joint each side shows portions of the end grain of its neighbour. For drawers and such-like articles, this, however well done, would look very unsightly; it is therefore seldom used for those purposes, unless the outsides are veneered, or covered with a thin sheet of some ornamental wood. Should it at any time be used for a drawer, the part corresponding to that shown as the front

in the single dovetail (Pl. D, Fig. 9) must be the front of the drawer. The reason readily appears from an examination of the shape of the parts composing the dove-tail. For the sake of explanation, it may be supposed that the joint were not glued, and that it did not fit very tightly. If the end of the socket marked CDAB were towards the front, it would be possible to pull the pins, out of their sockets, as there is nothing to prevent their coming out; but if much greater force were used to separate the parts in the other direction, it could not be done, because the broad parts of the pins could not be pulled out through the narrow openings. There is a method of making the dove-tail joint for drawer fronts by which the end grain of the side is kept concealed from view, and this does away with any necessity for veneering in order to hide the joint. This mode of making the joints between sides and front is adopted only for drawers that are to be painted or stained and varnished, and may be used with advantage in drawers that are to be veneered with mahogany, rose-wood, or any fancy wood.

Dove-tailing for Drawer Fronts or Lap Dove-tail.—The form of joint generally adopted for connecting the front of a drawer with the sides is known as the lap dove-tail. This joint is rather more difficult to make than the one last described, but the difficulty of construction is confined entirely to the front part, the side being cut in a manner exactly similar to the ordinary dove-tail joint. When the amateur artisan has occasion to make this joint, he should (after the several parts are trued up and sized with the plane) first cut out the side, in the manner already described but taking care that the depth of the pins is somewhat less than the thickness of the front. The thickness of the side-piece should be rather less than the thickness of the front. When the side is completed it should be laid in position on the end of the front and the shape of the pins marked with a sharp pencil. The sockets must then be carefully cut away with a chisel. The different parts of this joint should fit each other well, as, indeed, should the parts of all other joints in woodwork; but, as in this case, a great deal of strain is thrown on the joints of the drawer in pulling it out, unless they are well fitted together the front will soon become very shaky.

Mitre Dove-tail (Pl. E).—The last joint of this description which has to be considered is the mitre dove-tail. It is very neat and moderately strong; there are no end grains showing and, if

well made, the joint itself is not noticeable. It is used when both strength and neatness are required.

The first thing to be done in making this joint is to cut the mitre or bevel. For the sake of making the explanation a little clearer, let us suppose that the pieces of wood to be united are of equal thickness, and let Fig. 1 (Pl. E) represent a horizontal section of the front, and Fig. 2 a horizontal section of the side; or, what is the same thing, let the figures in each case represent the upper edge of the boards. Each board must be cut so that the edges marked A in each must meet. In each take the distance A B equal to A C, the thickness of the board, and with the square draw the straight line B H, and join the diagonal A H. Along A C and A B measure equal lines, A K, A E, and through E draw the line E D F with the square, and through K the line K D G parallel to the edge A B or C H. Let this be done on the lower edge of the board as well, and with square or marking-gauge trace a line from F, along the inner surface, along the whole depth of the side, from upper edge to lower edge. Lay the tenon-saw along this line, if it is not too long, in which case it must be cut with the chisel, and cut into the wood until D is reached. Then with a sharp chisel cut away the wood along the part A D of the diagonal A H, removing entirely the shaded part in each board, namely, A D F C. The sockets will now have to be cut in the part G D F H, in Fig. 1 and the pins in the part similarly lettered in Fig. 2. The great thing in making this joint is to make the bevelled part, A D E, in each precisely similar. If the side is of less thickness than the front, the bevel A D must be cut in the same manner, and of similar dimensions in each. As far as the rest is concerned, the length of D G or H F, in Fig. 1, must always be exactly equal to the length of F D or H G, in Fig. 2. The elevations of the ends of the two boards to be joined are shown in Figs. 3 and 4, Fig. 3 representing the end of the front, and Fig. 4 the end of the side. In figs. 5 and 6, the bevels or mitres at A, A, and the pins in one and the sockets in the other are drawn in isometrical perspective. It is not possible, for obvious reasons, to give an illustration of this joint when fitted together and complete, nor indeed would it be needful even if it were possible.

By the aid of the illustrations no amateur can fail in making this joint, if he understand the mode of making the single dovetail and of keying two pieces of wood together at an angle, though he may experience some difficulty at first. Of course he will readily understand that it is in cabinet-making, rather than

in carpentry and joinery proper, that such a joint as the mitre dove-tail joint is chiefly required. For all operations in which strength, rather than nicety, is requisite, the simpler kinds of joints, which are easily and more quickly made, will be found to be both suitable and sufficient in every respect.

Corner-locking or Box-pin Joint.—This very effective method of joining the edges of boards at right angles has been introduced in recent years and is commonly seen in boxes and cases containing imported goods. The alternative pins and sockets along the edge of the board are of the same width and instead of being cut at an angle, as in dovetailing, are square. When neatness is not a matter of great importance it may be adopted as an alternative to dove-tailing and will prevent no difficulty to the amateur who has mastered the instructions given above with regard to that method of joining boards. As in all work of this kind, however, care and precision are required.

Framing-joints (Pl. F).—The joints used in connecting framework are all variations of the **mortise and tenon joint,** which is shown in its simplest form, the **angle bridle or open mortise and tenon,** in Pl. F, Fig. 1. It consists of a tongue or projection formed on the end of one piece of wood so as to fit closely into a corresponding cavity which has been cut in the other piece and in which it is secured by means of pins, wedges, or glue.

Fig. 3 represents an upright with the lower end cut into the form of a tenon; and a piece of wood cut in such a manner that the tenon may fit into the cavity, which is called a mortise. It may be supposed that the width of each piece of wood is 3 in., and the depth 4 in., that is to say in the drawing of the tenon 3 in. from A to B and 4 in. from A to C, and in that of the mortise 3 in. from X to Y and 4 in. from Y to Z. In this case, the mortise is not to be cut right through the wood, but the tenon is to be made 3 in in length, so that it will not show itself in the lower surface or bottom of the piece of wood. The width of the tenon, and therefore, that of the mortise also, is 1 in., and we must suppose that the wood has been planed up and true on all sides. First of all, a distance of 3 in., the depth decided on for the mortise, is measured from the end of the upright, say from F, G upwards to D, E. This distance is marked with the pencil, and by the aid of the square, the straight lines B A, A C, C L, and L B are marked, one on each side or surface presented by the upright. As the width of each piece of

wood is 3 in., and the tenon is to be in the direction of its depth, that is to say, from A to C or from B to L, and as it is usual to make the tenon just one-third the width, the mortising gauge must be set so that the first point is distant exactly 1 in. from the head, and the second, which is the point nearest the end, 2 in. from the head. The head of the mortise must be brought first along the edge B O, where the points will mark out the lines E G, D F; then against L P, where the lines K N, H M will be marked; and lastly, against the edge O P, where the lines G N, F M will be marked. The upright, if it be a short one, may be held perpendicularly in the bench-jaw or vice, when the planes H M F D, K N G E will be cut through with the tenon-saw. The timber is then laid on the bench, and the tenon-saw is passed through the planes C H D A, B E K L, when the rectangular blocks on either side of the tenon will be separated from it, and the tenon be left in a fit condition to be inserted in the mortise when made.

A distance of 4 in. having been measured off with the rule along the line X at the place where it is determined to cut the mortise, the square is applied to this edge, and the lines V V', W W' at right angles to the edge are duly marked off. Then the head of the mortising gauge is applied to the edge Y or X—either will do provided that the timbers are of the same width, which they should be if they have been planed up to gauge—and the lines R S, T U, marked on the upper surface, represented by X, Y. The parallelogram, T R S U, the length of which is with the grain of the wood—a mortise being nearly always with its length parallel to the grain—shows the place where the mortise is to be cut, and its size, which corresponds exactly with that of the tenon. The wood is then laid on the bench, or, if long enough, on a pair of stools or trestles, and the operator proceeds to cut out the mortise with a mortising chisel of the breadth of the mortise—namely, 1 in., sinking it gradually to the depth of 3 in., or a trifle more, that the shoulders of the tenon may rest on, and fit closely to the upper surface of the wood in which the mortise has been cut. If the wood is long enough to be laid on trestles, the operator sits astride it, and proceeds to cut the mortise, but whether on the bench or on trestles the mode of operation is the same; a notch is first taken out in the middle of the mortise, and the cutting is carried gradually to the end, first in one direction and then in the other, till a depth of about $\frac{3}{8}$ in. or $\frac{1}{2}$ in. has been taken out over the whole of the mortise,

When the mortise is to be cut right through the wood, lines should be marked with the square round three sides or faces of the wood (or all four, if preferred), as V′V, V V″, V″A′ and W′W, W W″ and W″B′ and the lines T′U′, R′S′, marked on the under part of the wood. When half the depth of the mortise, or nearly so, has been cut, the wood should be turned upside down and the rest of the waste wood taken out from the other side. By this means the mortise will be carried through in such a manner from side to side of the wood that the upright cannot fail to be perpendicular to it. If the mortise is cut in one direction throughout the whole operation, it may possibly incline a little to one side or the other, and the other side of the hole will not then be true to gauge. This has the effect of throwing the upright piece out of the perpendicular. Whenever the amateur, therefore, is going to cut a mortise right through a piece of wood, he must remember that it will be safer for him to sink the hole from both sides.

When the mortise is cut, try in the tenon, and if too tight to go down to the shoulder without using considerable force, rub some red lead about it and again try it in. The lead will show where the joint binds. Carefully pare off those places thus marked until the mortise is large enough to admit the tenon. When it is brought home close to the shoulders it may be tightened up and secured by the simple method of draw-boring.

Draw-boring.—In draw-boring a hole of suitable size is first bored through the sides of the mortise. The tenon is then inserted and the centre of this hole lightly marked on it with the boring bit. The pieces of wood are then taken apart and the hole bored in the tenon somewhat nearer the shoulder than the mark made on it. When the parts are again fitted together the holes will not exactly coincide, but when a hard wood pin with a tapering point is driven through a strain is exerted and the tenon is drawn further into the mortise so that the shoulders of the former are pressed tightly against the side of the piece of wood into which it is fitted. To avoid the risk of breaking the wood pin the actual process of tightening is sometimes performed with a short, tapering bar of steel, polished and fitted into a handle. It is known as a joiner's *draw-bore* pin. As a general rule, pinning is used in all cases where the tenon is not less than three-quarters of an inch in thickness. When thin wood is used it may be advisable to adopt the plan of tightening the joint by means of wedges,

or, where the mortise and tenon are very small, of simply gluing the end of the tenon before inserting it in the mortise.

There are many varieties of the mortise and tenon joint, but the principle and the method of making them is much the same in all cases. Beyond indicating the uses of a few of these varieties it will not therefore be necessary to deal with them separately.

Double-tenon.—When the wood to be joined is very thick or wide, instead of having one tenon one-third of the thickness it is usual to have two tenons, and consequently two mortises. In this case the thickness of the tenon is about one-fifth that of the wood.

Lock-mortise Tenons.—Pl. II, Fig. 5 shows the form of double tenon used in joining the middle rail of panel doors to the stile when a mortise lock is afterwards to be fitted.

Haunched-tenon (Pl. F, Figs. 2 (square) and 4 (bevelled)).—This form is useful, when, as in the case of framing a door, it is desirable to retain as much wood as possible around the mortise, so that the frame may not be excessively weakened, and the joint may stand the pressure of wedging. The width of the mortise is lessened and the tenon is shortened.

Bare-faced Tenon.—This is used when one part of the frame to be joined is thicker than the other The mortise is then cut in the middle of the thicker piece of wood and the tenon is cut with one shoulder only.

Stub Tenon.—This is a short tenon of the ordinary kind used in joining up the framework of partitions and in work where the joint will not be subject to any tension. It is not taken through the stile but enters for a short distance only.

Tusk or Stump Tenon.—This form of joint is used by carpenters in framing the joists so as to leave openings for fire-places and stairs. In this case, the thin tenon is used to keep the shoulder up while any heavy cross strain is taken up by the stouter section of the joist. By adopting this method the mortise cut in the trimmer or cross-piece is reduced to comparatively small dimensions whilst the actual tenon may be made nearly the full depth of the joist. It is not probable that the amateur will at any time require to make this joint and it is unnecessary therefore to do more than mention it.

Miscellaneous Joints.—Of the great variety of joints used

by carpenters and joiners the following may at one time or another be found useful by the amateur.

Lap-joints or **Halving-joints.**—These joints are extremely simple to set out and require little skill on the part of the worker when making them, as the operation consists merely of reducing to one half the thickness of the two pieces of wood to be joined, as shown in Pl. E, Fig. 8. It is a joint which materially weakens the wood, but where strength is not essential will sometimes be found very useful.

Pl. E, Fig. 7 shows the manner in which timbers may be halved and notched into one another. It may be assumed that the timbers A and B are two pieces of quartering 2 in. square after being planed up. The marking gauge is set to 1 in. and applied to the timbers, tracing out the lines C D on A, and E F on B, and similar lines on the sides opposite to these, which are hidden from view. Spaces of 2 in. are then set off, where the pieces are to be notched into each other, and guide lines drawn with the square round the three sides in which is contained the piece to be notched out, as at G H K, L M N in B. These lines serve to direct the tenon saw, which is passed through the lines H K, M N, till it meets the transverse lines traced by the gauge. A broad chisel and mallet is then called into requisition to remove the waste wood, the edge of the chisel being in the guide lines traced by the marking gauge, and the handle struck lightly so as to drive the chisel gently into the wood. After this has been done once or twice, first on one side and then on the other, the piece will come away, leaving a space, as shown in the drawing. Any inequality of surface that may be caused by projection of fibres at the bottom of the notch may be pared away with the chisel. A notch precisely similar to that which has been made in B is made in A; the mode of operation in each case being exactly alike. The two pieces are then fitted one into the other, the notch in each receiving the part left in the other after the notch has been made, and the piece which was previously contained in it removed. When fitted together the wood presents the appearance shown at X. A couple of holes should then be made with a boring bit, and the two pieces be fastened together by means of wooden pegs. It is better to put one peg in on one side and the other on the side opposite to it, instead of driving in both on one side.

It has been said that this is a weak kind of joint, and this must of course be the case on account of the great reduction

made in the thickness of the wood in both pieces. It is useful, however, in joining cross-pieces, for the pressure of the shoulders of the notches on the surfaces on which they rest gives great rigidity to the joint, so that it is impossible, if the pieces have been accurately cut and let into one another, to move the arms of the cross thus formed in any direction. It is bad when the *end* of one piece of wood is halved into another piece, as in the case of an upright into a horizontal piece, or *vice versâ*, and it is even worse when the ends of two pieces are halved for the purpose of joining the two pieces at right angles. The method may, however, be quite properly adopted in the construction of light framework, which, from the nature of its use, will not be subjected to any breaking strain. As an example may be taken the gratings used in bath-rooms and in boats. In these gratings a number of pieces, all lying in one direction, are halved into a number of others at right angles to them, the ends on all sides being let into a frame a little thicker and wider than the cross-pieces.

Scarfing-joints (Pl. E).—Halving, when adopted as a method of joining timbers longitudinally, or end to end, is commonly described as *scarfing*.—Figs. 8 and 9 show clearly the manner in which scarfing is performed. In joining timbers in this way the length to which each end should be rebated should be five or six times its depth; that is to say, if the depth or thickness of the wood from C to D be 3 in., the length of the rebate from A to B should be from 15 in. to 18 in. The iron fish plates shown in the illustrations are not always necessary but greatly increase the strength of the joint.

The joint may be fixed with nails or screws. It is a good plan to cut each overlapping end at an angle, as at A B C, B C D, as the end is then held down and prevented from springing outwards by the projecting tongue with which each end is fitted. In all cases of making a joint of this kind, it is better that the line of juncture (A B in Fig. 8, and B C in Fig. 9) should show at the upper and lower surface of the timbers when joined, unless there be a bearing in the centre of the joint, or the distance between bearings on either side be but short.

Other modes of scarfing are illustrated in Figs. 10, 11, and 12. Fig. 10 shows the simplest kind of scarf joint that can be made. This scarf is known as a *splay* joint and is useful in general repairing work. The ends of the pieces are carefully pared down at a long slope until they can be fitted together as

shown, the end of one piece laying upon and along the end of the other. In Fig. 10 the line of junction A B forms a straight line from A to B. In Figs. 11 and 12 it does not, the extremities of the timbers being cut in the form of a step—the upper timber in Fig. 12, or that which appears to be uppermost in the section presented to the eye of the observer, being in the line A C D B, and the lower in the line B E F A. In Fig. 11 grooves of exactly the same size are cut in the faces of the timbers as at C D. Their positions should be such that when brought together they should nearly, but not quite, coincide. Into the double groove thus formed a taper wedge is driven, and this has the effect of locking the shoulders A B into the angles cut for their reception. In Fig. 12 this wedge (which must taper slightly in either case) bears against the surfaces C D and E F, and draws the ends of the pieces thus connected well together, forcing, as in Fig. 11, the extremities A and B into the angles cut to receive them.

Mitre-joints.—To mitre the corners of a rectangular frame, the moulding of which the frame is made must necessarily be cut at an angle of 45°. In this case it is known as a *right* or *true* mitre. The sides of the pieces joined may, however, form any other angle, as, for example in the case of the framing of a bay window, but whenever the line of the joint bisects the angle the term "mitre" is used Upon the accuracy of setting out the mitre so that the angle may be truly bisected will depend the proper intersection of the lines of the various members of the moulding. As an example it may be supposed that A B (in Pl. E, Fig. 13) is a piece of moulding. It is obvious that in order that the piece A C D may meet and fit at right angles to the piece B C E, as shown by the dotted lines at C F E, the moulding must be cut through in the lines C D and C E, which are at an angle of 45° to A C and B C respectively. The portion D C E having been cut away along the straight lines D C and C E, the piece of moulding A C D will fit accurately against the piece B C E—every line, projection or depression in one piece meeting and fitting exactly against the corresponding parts in the other piece. To ensure the necessary precision, mitre blocks, mitre shoots (see p. 79) or templets are used Generally, the moulding is sawn off in the mitre-box, rather full in length, and then planed down to the exact dimensions on the mitre shoot.

Clamping consists in joining narrow pieces of board to a wider

Plate G. WORK-BENCHES.

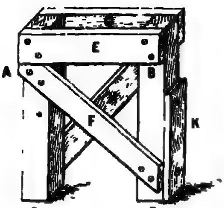


Fig 1

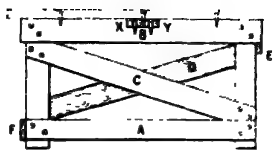


Fig 2

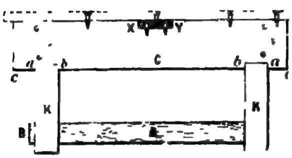


Fig 3

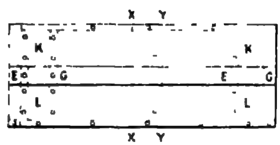


Fig 4

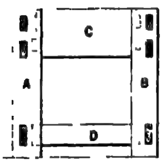


Fig 5

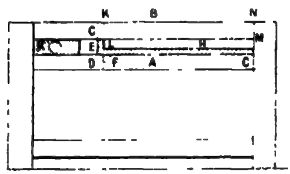


Fig 6

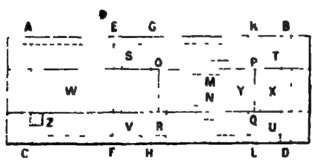
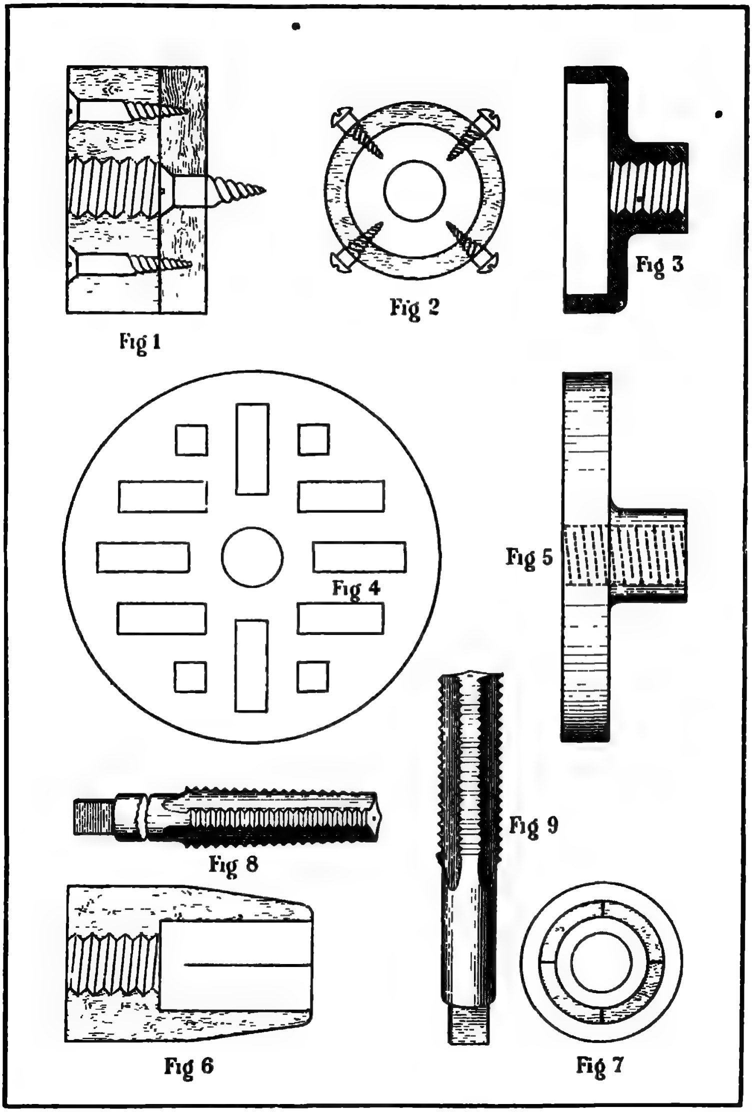


Fig 7

(1) End trestles, (2) Back elevation, (3) Front elevation, (4) Plan of top, (5) Framework of ends of permanent bench, (6) Front elevation of permanent bench, (7) Plan of top of permanent bench.

Plate H. WOOD-TURNING—CHUCKS, etc.



(1) Taper screw chuck, (2) Bell-chuck; (3) "Master" chuck, (4 and 5) Face plate, (6 and 7) Split cup chuck, (8 and 9) Screw taps

piece in such a way that the grains of the wood run transversely and may so counteract any tendency of the wider piece to cast or warp. This method is used in the making of drawing boards and blackboards. The clamps may be secured to the board either by means of screws, by tonguing and grooving (p. 113), by dowel pins (p. 94) or by the haunched tenon joint (p. 125). In good class work the clamp is often mitred into the board.

Fox-tenoning or Fox-wedging is a form of mortise and tenon joint sometimes used in cabinet work when it is not desired that the end of the tenon should appear at the edge of the framing. The mortises are cut for a certain depth only into the frame and are somewhat larger inside than outside. Before the tenon is inserted it is split sufficiently for the insertion of one or two thin wedges. When the tenon is forced home the wedges are driven farther in and expand the tenon, so that it fills the lower end of the mortise. The result is a very strong joint.

Secret-fixing or Slot Screwing is used when as in the case of fine mouldings or polished surfaces it is desired that the fixing should not be visible. A number of strong screws are turned into the groundwork in horizontal lines and their heads projecting uniformly about ½ in. Holes large enough to take the heads of the screws are bored to this depth in the back of the moulding or panel in positions corresponding to those of the screws, and from these holes, slots of a dove-tail shape, and wide enough to take the shank of the screw, are cut in the direction in which the piece is to be driven on. The holes are then fitted over the heads of the screws and the piece to be fixed is slid or gently driven into position. A similar method is sometimes adopted in joining the edges of boards. In this case the joint is known as a screwed butt joint. It has the advantages of being very simple to make and of being easily taken apart when necessary.

CHAPTER VI

THE WORK-BENCH AND ITS FITTINGS

To the professional carpenter and joiner who is constantly engaged in work of a varying character a properly constructed bench with numerous adjuncts may be more or less essential. The work of the amateur artisan will be, however, as a general

rule, of a much more simple nature, and though even in his case there may be occasions when a well-equipped joiner's bench would prove to be a convenience, the great majority of the operations which he will perform will require nothing more elaborate than a strongly made plain bench or table, which, when necessary, can be rigidly fixed and fitted with simple contrivances for holding boards during the process of planing. The actual size and position of such a bench will be determined largely by individual circumstances and requirements.

The bench may be either fixed or movable and, with regard to position, it may be against a wall of the workshop or shed or it may stand in the middle of it, so that there may be free passage all round it. As a rule, the amateur will find it convenient to have it against the wall of his shed, and if possible immediately under the window by which the shed is lighted. A large bench need not be fixed, as its own weight will keep it in position; but a small one, such as an amateur artisan will generally have, will be all the better for being secured to the side of the shed or to the ground, if possible. For the amateur, then, there can be little doubt that the bench should be against a wall and fixed; but of course there are cases in which this would be impossible, and in determining position, etc., every one must be guided by the necessities of situation, light, etc., and settle these points as may best suit his own convenience.

The fixing is easily managed. Four iron brackets, having two arms at right angles to each other, and pierced and countersunk for screws, will be all that is necessary. If two of these brackets be screwed to the sides of the bench near the top and also to the wall, and the other two secured to the front legs and the floor, the bench can neither tilt away from the wall under pressure nor slide along the floor under the thrust of planing. When the bench stands against a wall, a wooden rail to which the bracket may be screwed must first be fixed to the wall in a horizontal position. As for the floor, if this be of stone, concrete, or even earth, it is always desirable that the bench should stand on a very low platform, and it will be better that the wall behind the bench, if it be of brick or stone, should be match-boarded. The utility of this will appear presently.

First, as to the dimensions of a bench; these must depend very much upon space, for the bench must be made according to the room at command. The following will be found convenient dimensions: *length*, from 5 ft. to 7 ft.; *breadth*, from 1 ft. 6 in. to 2 ft. 6 in.; *height*, from 2 ft. 6 in. to 3 ft. The height should be

regulated according to the stature of the user, as in planing and similar operations it is desirable not to stoop over the bench more than is absolutely necessary. Excessive length should be avoided, as a long bench is liable in course of time to become slightly hollow in the middle, and this is a serious defect. An average sized bench for general use might be 6 ft. by 2 ft. with a height of 34 in.

A glance at any tool-maker's catalogue will show that ready-made benches, well fitted, and suitable either for amateur or professional workers, may be obtained at moderate prices. It is assumed, however, that the handy-man will prefer to make one for himself which will in every way suit his convenience. In order to meet varied requirements it is proposed to describe the making of a rough and ready bench which can be easily put together either for temporary work or as a makeshift even in the workshop itself, and afterwards the more complete and permanent bench which in his progress he may at one time or another desire to possess.

Temporary Bench (Pl. G).—First get out four pieces of quartering, about 3 in. by 2½ in. and some strips of board about 3½ in. wide and 1 in. thick. A board of white deal, 11 in. wide, may be ripped down in three lengths for this purpose. Three pieces of the same kind of board 6 ft. long must also be provided, and some 2 in. and 2½ in. screws; about three dozen of each will suffice. In putting together a temporary bench of this description, or any kind of work that is to be taken to pieces again, use screws instead of nails, as by screws less injury is done to the wood, and the material may be utilized when it has served its first purpose for something else. And more than this, no nails or fragments of nails will be left in the wood to damage the teeth of a saw or the edge of a plane-iron.

Having prepared the wood, take two pieces of quartering, and lay them down on a flat surface parallel to each other, and two feet apart, from outside edge to outside edge, that is to say, from A to B, in Pl. G, Fig. 1, and from C to D; cut a piece of wood E from the wood that you have ripped down, taking care that the ends are square with the top and bottom, and screw it to the quartering with some of the larger screws—not less than four being used. Then screw on another piece, F, diagonally from A to D, taking care that the pieces of quartering are still exactly two feet apart along the line included between C and D. Turn over the pieces of wood thus screwed together, and screw on the

pieces, G, H, in a precisely similar way on the other side. When raised from the ground the trestle that has thus been made will be found to be as strong and rigid. Complete the work by screwing on a piece of wood, K, on the outside face of one of the legs, reaching from the ground to a line just *ten inches* from the top of the leg. This, it must be borne in mind, will be the *front* of the trestle. As soon as this is done make another trestle similar to this with the remaining two pieces of quartering, and some more of the wood that was ripped down at the commencement of the work, when getting out the wood all ready for it.

It is now necessary to connect the trestles in such a way as to offer a solid framing for the reception of the boards that are to form the top of the bench. The back and front will be connected in quite a different manner and, to make this perfectly clear, the elevation of the back is given in Fig. 2, the elevation of the front in Fig. 3 and the plan of the top in Fig. 4. The trestles have been made precisely alike, so that when they are placed upright, the diagonal brace F in the illustration of the trestle will be *outside* in that which stands to the left hand and inside in that which stands to the right. Similarly, the brace H will be *inside* in that which stands to the left and *outside* in that which stands to the right. Care must be taken to preserve this arrangement with the braces of the trestles or some difficulty will be occasioned in connexion with the fixing of the diagonal braces at the back. Having cut two slips of wood, one 5 ft. 6 in. long and the other 5 ft. 8 in., place the trestles so that the front of each rests on the ground and the back is uppermost. Screw the shorter piece to the trestles, as shown in A in Fig. 2, and the longer piece as shown in B. The object in having the upper piece 1 in. longer on either side than the lower piece is that its ends may abut against and cover the slip marked E in the diagram of the trestle, on one side, and the slip marked G on the other. Then screw on the diagonal brace C on the outside, and the brace D, also placed diagonally, on the inside. In Fig. 2, E shows the end of the diagonal brace A on one side and F, the end of the diagonal brace H, on the other side in the diagram of the trestle. Of course, these ends are not in the same but in different trestles.

To keep the trestles from displacement during this operation, it will be found useful to nail two slips of wood across to the face or front of the trestles before placing the front on the ground, taking care that the trestles are kept the correct distances apart, which is 5 ft. 6 in., the length assumed as convenient for the

length of the slip A in Fig. 2. Before turning the frame over to put on the front, screw to the inside of the front legs the slip shown at A in Fig. 3. In this figure, B shows the grain end of the diagonal brace F, in the diagram of the trestle. As soon as the slip A in Fig. 3 has been screwed on, the frame must be turned over so that the front is uppermost and the back on the ground. The reason why the slip A is not screwed on to the *outside* of the front instead of the inside is that the slips that were screwed to the face of the front leg of each trestle (see K in diagram of trestle), would cause it to project beyond the face of the board in front of the bench, and be in the way.

The board C, as well as the pieces intended to form the top of the bench, was cut exactly 6 ft. in length. Before putting these in their places it may be as well to *rub them over* with a plane, as the carpenter says; but this is not absolutely necessary as the bench is merely intended to serve a temporary purpose. The board C is 11 in. wide, and the top of each slip marked K is just 10 in. from the top of the trestle, so two notches an inch deep must be cut in the lower edge of the board, so that it may fit over the top of each slip, the upper edge being on a level with the upper edge of the trestles on either side. As the length, from outside edge to outside edge of the legs of the trestles front and back, is 5 ft. 6 in., and the board C is 6 ft. long, *a c* and *a′ c′* will be just 3 in., and the length of the notches *a b* and *a′ b′* will be exactly the width of K, which is the width of the narrowest part of the quartering, namely, 2½ in. Cut the notches so that they may fit tightly over the tops of the slips K, K; and when the board is fairly placed in position as shown in Fig. 3 screw it firmly to the trestles, taking care to bury the head of every screw well in the wood, to do which with ease a depression for its reception may be made with a bit for countersinking. Every screw should be greased before it is inserted, as it can then be withdrawn easily whenever the bench is taken to pieces.

The frame is now nearly complete, but, before putting on the top, two notches should be cut one at X Y in B in Fig. 2, and the other at X′ Y′ in C in Fig. 3 about 4 in. long and 1 in. deep in order to receive a bearer, crossing the frame from the slip B to the board C, so as to help to support the boards which form the top. This bearer is shown in the plan of the top in Fig. 4 by the dotted lines X X′ Y Y′. When this has been secured with screws, the frame is ready to receive the top, which will be 2 ft. 2 in. from outside to outside. The board K K must therefore be placed on the top, so that its outer

edge is flush with the slip B, in Fig. 2, and the board L L so that its outer edge is flush with the surface of the board C in Fig. 3. They must then be screwed down as indicated in the figures, to the slip B, the board C, the cross-pieces E G of each trestle, and the bearer X X′ Y Y′, the positions of which are shown by the transverse dotted lines in Fig. 4, the horizontal dotted lines showing the edges of the slip B and the board C. The dotted lines in Figs. 2 and 3 show the position of the boards K K, L L, when placed on the top of the frame. A space of 4 in. now remains between these boards; this may be left as it is, but to save the annoyance of small tools and fittings falling through when thrown on the bench it is better to cut a slip to fit tightly into the opening and close it up altogether.

The bench is now complete as far as it goes and is strong enough for any practical purpose, though its appearance may leave something to be desired. Certain adjuncts are, however, required and these, which will serve as substitutes for the bench-vice and bench-stop, must now be described. If the amateur is content with a bench of this sort until he can find time to make a better one, he may as well put in a bench-stop at once as described further on, but in the bench under consideration it is sought to injure the wood as little as possible and a convenient substitute for a bench-stop may be found by inserting two thick, stiff screws close together when planing the surfaces of pieces of quartering and other narrow wood and further apart when planing the surface of a board. These screws can be raised or lowered at pleasure to suit the thickness of the wood that is being planed. They should be thick, as it has been said, and have a large deeply-cut thread. The same object may be attained in another manner, namely, by nailing or screwing down a slip of wood to the top of the bench but as no piece of wood that is less than or equal to, the slip in thickness can be planed, with such a contrivance as this, it seems that the screws afford a more serviceable arrangement.

A contrivance for holding a board against the front of the bench while its edges are being planed must now be sought. At the distance of from 9 in to 12 in. from the end of the board which forms the front of the bench and continued along its entire length is screwed a slip of wood, about 1½ in. thick and 1½ in. deep. This slip may be fixed in this position, and remain so until the bench is taken to pieces; its upper edge should be about 4 in. from the lower edge of the front of the bench. As there is now a space of 8 in. between the upper edge of

this slip and the surface of the board, which forms the top of the bench in front, it is manifest that any board, whether 9 in. or 11 in. wide, may be planed along its uppermost edge, while the lower edge rests on the slip. If the wood the edges of which are to be planed be very narrow, another temporary slip must be screwed on to the bench front higher up, as a rest to receive the lower edge of the board, so that the upper edge may be raised above the top of the bench. A stout block of hard wood, say 2½ in. thick, 6 in. wide, and 8 in. long, into which a deep bevelled rebate has been cut so as to form a kind of button to fit over the end of the board, should then be screwed to the front of the bench, care being taken to bring the line through which the screws pass exactly opposite the central line down the front of the leg of the trestle that stands to the left, so that additional strength may be obtained by the entry of the screws into the leg of the bench. Substantial screws, about 5 in. in length, should be employed for this purpose and the heads should be sunk in the block, provision for this having been made with a countersink. When the board has been placed in position, abutting against the block, two wedges, flat on the side next the board and bevelled on the other side to correspond with the slanting surface of block must be driven in with two or three sharp blows. These wedges will hold the board as firmly as a bench vice. There are other means of making a stop, or substitute for a vice, to hold the end of the board, but they have no special advantages and it will be unnecessary to describe them.

The merits of the bench described above are that it is easily made even by the amateur, and there is nothing which presents any difficulty that cannot be overcome in the way of providing substitutes for the bench-stop and bench-vice. It is unlikely, however, that the amateur will rest content with such a bench as this, however well it may serve temporary purposes, and one of his first serious undertakings in carpentry, when he is able to use his tools tolerably well, will be to make a bench for permanent use in the workshop and fully equipped with the various fittings suited to his particular requirements.

Permanent Bench (Pl. G).—For the bench which we are about to describe, the dimensions already suggested, 6 ft. by 2 ft. and 34 in. in height, will be convenient for the majority of amateurs.

In making such a bench the first step to be taken is to provide some quartering of red deal of different dimensions, that is to say, about 12 ft. of 3 in. by 2½ in. for the uprights or legs, about

36 ft. of 2½ in. by 2½ in. for the horizontal pieces of the frame, 4 ft. of board, 9 in. wide and 1½ in. thick, and 24 ft. of board 9 in. wide and 1½ in. thick. If the bench is to be 34 in. in height measuring from the ground to the top, cut off 4 lengths of 2 ft. 9 in. from the wood provided for the uprights and plane them up. Next cut five lengths of the smaller quartering 6 ft. long and two lengths 2 ft. long and plane these up also; lastly, cut two pieces of the 1½ in. board, 20 in. in length and plane up these as well, bringing the sides to a smooth surface and making the edges true and square.

When this has been done, the necessary steps may be taken for putting all these pieces together, which should be done with mortise and tenon joints. Let us frame together the ends first of all, and let Fig. 5 (Pl.G) serve as an illustration of the method to be adopted in doing this. In this representation of either end of the bench, let the broad side or width of the uprights be supposed to face the reader, as shown in A and B. The piece C has already been cut 20 in. long; cut D to the same length, and then proceed to cut the ends of each into tenons 1 in. in length. Cut the tenons at either end of D to one-third the thickness of the wood, but let the ends of C be cut in the manner indicated by the dotted lines in Fig. 5. The wood is 1½ in. thick, therefore a rebate must be cut in it 1 in. wide and ½ in. deep, and the rebate thus made must be cut as shown in the illustration so that there is a tenon all the way down for the width of ½ in., the remainder being cut away so as to leave two projecting pieces about 2½ in. long. This is an adaptation of the haunch-tenon, the form of which is shown in Pl.F at Figs. 2 and 4. Cut mortises in A and B to receive the tenons that have been cut at the ends of C and D, and fit the pieces together. The tenons should fit tightly into the mortises, but not so tightly that they cannot be withdrawn without great force. The opposite end must be made in precisely the same way.

The narrow faces of the uprights were to be 2½ in. wide, and it will be useful to suppose that these are the actual dimensions after the wood has been planed up. The bench is to be 6 ft. long, from end to end, and the length of the horizontal pieces of the framing, from shoulder to shoulder, of the tenons at the ends, must be exactly 5 ft. 7 in. We are supposing that the boards composing the top and front are to be 6 ft. long, and that their ends are to be flush with the ends of the bench; but such a frame as is now being described will allow of the use of boards 6 ft. 6 in. long, so that they will overlap 3 in. at the ends on either side. To return to the horizontal pieces of the framing, the tenons

at the ends of these must be 2½ in. long and one-third of the width of the stuff. The tenons at the ends of the uppermost horizontal bars should be cut as shown by the shaded parts in Fig. 5, three in the front legs, and two, one at the top and one at the bottom, in the uprights behind. A third bar may be added in the back part as well as in the front, as this will give additional strength and firmness to the bench. The reason is now clear why the tenons of the pieces C and D in Fig. 5 are not made longer than they are, for being no more than 1 in. in length they do not interfere with the tenons of the horizontal pieces being carried right through the uprights so as to show the end grain. When the whole of the framing has been put together, the front will present the appearance represented in Fig. 6 and if a third rail has been put in between the two others at top and bottom, the back will have a similar appearance. When it has been ascertained that all the tenons fit fairly tight into the mortises and the shoulders of the tenons fit closely to and squarely against the parts on which they butt, they should be glued and finally put into place and the whole frame pinned together with wooden pegs, driven through each mortise and the tenon which is thrust into it. The frame is now complete and ready for the top and front.

In making a bench the uprights intended for the front legs are often made 1½ in. wider than the back uprights so that the board that forms the front of the bench may be recessed into it. As however in the present case no provision of this kind has been made for letting the front board into the upright, all that is required to be done is to screw a piece of wood on to the face of the upright of the same thickness as the board, in order that the latter may appear flush with the face of the projecting part thus added to the upright.

With regard to the centre rail A in Fig. 6 it may be added to the framing or dispensed with altogether. When introduced it gives additional stability to the structure, if we may apply such a word to a simple framing of uprights and rails; and although its presence is more important in the front than in the back of the bench, it is better to have it in the back also, for reasons which will appear presently. It is also desirable to put a board at the back of the bench similar to that which is fixed in front, faces being screwed on to the legs below to bring them flush with its surface, or a rebate being made for its reception as already described. The boards at front and back are not to be screwed on until the interior of the bench is completed.

At the end of the bench to the left hand the wooden screw of the bench-vice will enter, and work backwards and forwards, and provision must be made for its reception. The space between the boards in front and behind must be left open so that nothing may hinder the progress of the screw, and no attempt must be made to enclose the bench by boarding up the space within which the screw works, as this would prevent us from making proper use of the old-fashioned bench-stop and bench-holdfast, if these be used in putting the bench together and fitting it up. The end to the right hand, however, may be boarded at the bottom so as to form a well for the reception of saws and large tools, which it may be convenient to stow away in such a depository. Returning, then, to Fig. 6 and taking this to be a fair example of the framing requisite in front and rear of the bench, the central rail A being introduced in both parts of the frame, insert a cross-piece of wood from front to back as shown at C D, cutting grooves for its reception to the depth of ½ in. in the rails A and B, and letting the end showing the grain project between the rails on either side and come flush with the outer surface of the rails, as at E. Screw a slip of wood to this cross-piece at F, and another to the end rail at G, and then lay pieces of board as shown at H from rail to rail, the ends being flush with the outer surface of the rails on either side. A shallow well about 6 in. deep will thus be formed for the purpose indicated to the right of the bench. Provision for the well must in all cases be made before the frame is put together.

The front board is next screwed on to the framing, and may be allowed to project a little beyond the uprights, say to the extent of two or three inches. The bench is yet incomplete however, for the bench-stop and bench-vice have to be added, and the top has to be put on. Of the bench-vice we can speak at once, but as the bench-stop has to pass through the top, mention of this may be left until the top comes under consideration.

The **bench-vice**—it must be remembered that we are now speaking of the wooden adjunct to the bench and not the iron "bench-vice" sometimes attached to one end of the bench to hold a piece of metal for filing—consists of a broad solid cheek, a wooden screw and a nut also made of wood attached to the framing or front board in which the screw works. The screw has a solid head perforated for the reception of a wooden bar which works easily in the hole and is furnished with a knob at each end to prevent it slipping out while the screw is being turned or when it is at rest if the bar should happen to be vertical. The

neck of the screw passes through a solid piece of wood about 18 in. long, 9 in. wide and 2 in. thick, and the shoulder of the screw-head abuts against this board and forces it against the front of the bench when the screw is turned in, or against anything which may be placed between this solid cheek and the front of the bench, and so holds it firmly. The thread of the screw is deeply cut and the screw itself, after passing through a hole cut for it in the front board of the bench, works in the large nut, or block of wood, which may be either fixed between the rails of the bench, or bedded against and screwed to these rails. If no rails are fixed, the block in which the screw works must be attached to the front board. This, it may be mentioned, is the most ordinary form of bench-screw in use. It may be purchased ready for fitting at any tool maker's at a small cost.

When cutting a tenon at the end of a rail or upright, the wood may be placed in the bench-screw and screwed tightly against the side of the bench, but when it is necessary to plane the edges of a board, some further support must be provided along the front of the bench. In the temporary bench, this was managed by screwing slips horizontally to the board forming the front, but in the permanent bench the same object is attained by making in the front board two or three rows of holes into which wooden pegs are inserted. The lower edge of the board to be planed rests on these pegs, the end furthest from the operator being held tightly in the bench-screw.

The plan of the top of the bench when complete is shown in Fig. 7. If there is to be no well in the bench, all that is to be done is to screw the two 9-in. boards originally provided to form part of the top on to the rails and boards at the front and back of the bench, and then to fill up the space of 6 in. remaining between these boards with another board cut to fit; but if it is desired to form a well, cut a strip 1½ in. wide off each board, reducing them to a width of 7½ in. and leaving a space of 9 in. between them when put into position. In the figure, the dotted lines from A to B and from C to D represent the edges of the boards forming the front and back of the bench respectively and the dotted lines from A to C and from B to D the edges of the end rails of the bench. The lines from E to F represent the upper edge of the board let into grooves formed by slips to form one end of the well, the end rail of the bench to the right being the other. Two bearers are notched into the boards at the front and back, and fixed in position as shown by the dotted lines from G to

H and from K to L. Before the boards forming the top are put on, the rectangular space S T U V is entirely open and forms the well. The boards on either side may now be laid on the top of the bench and marked, so that two slips, M and N, may be screwed to their under surface, forming, with the bearers G H and K L (or such of these as may project beyond the boards W, X, the edges of which rest on them), a support for the board Y, which forms the cover for the well. A rebate might have been cut in the board on each side of the well at M and N to receive the cover, which must also be rebated, to fit into the rebates of the others, and the slips depensed with, but the amateur will often find it useful to form a rebate in this manner instead of cutting one, and this mode of doing so may as well be adopted here. Moreover, it suits the width of the boards employed, which are 9 in. wide; and if a rebate of ½ in. had been cut on either side it would have been necessary, in order to save waste, to form the rebate in the well cover by bradding on slips ½ in. square. Next, a board 9 in. wide and 6 ft. 6 in. long must be taken, and cut into three parts, corresponding to the parts marked W, Y, and X in the figure. The pieces W and X may be joined to the boards on either side by a groove and slip-feather (see p. 113), or by a dovetail groove the whole being glued up, or dowelled together with pegs. When dry, the top may be screwed on to the bench, the heads of the screws being deeply buried in the wood and pelleted (see p. 93). When the top has been screwed on, the opening O P Q R is left for the admission of tools into the well, and the piece of board Y will drop into this opening. It will perhaps occur to the reader that the opening to the well has been made as large as possible first to facilitate the putting in and taking out of such a tool as the hand-saw, and to leave as little space as possible covered between the ends and sides of the well so that the hand may be passed with ease to any corner of it in search of any small tool that may have been put in or dropped in. The amateur, however, is advised not to keep any small tools in such a depository as the bench-well, which is best adapted for saws, planes, squares, hammers, and any large and heavy tools of this kind.

Before proceeding to deal with the various adjuncts of the bench of which the amateur will from time to time be in need, it will be well to describe the manner in which the fixing of the bench-vice is completed and also to give particulars of the form of vice which, although somewhat more expensive, is now often adopted in preference to the older variety already described. The

disadvantage of the ordinary bench-screw is, that it is apt to get strained, and fails to grip fairly any thick piece of wood, such as a piece of quartering, placed between the cheek and the front of the bench. The head of the screw is in the centre and bears directly against the centre of the cheek, and it is not difficult to see that when a piece of wood is put in on one side and the cheek screwed tightly up against it, there will be a tendency on that side of the cheek which bears against the wood to project a little further than the other side, which is pressed inward by the screw-head, but meets with no piece of wood within it to counteract this force and keep the inner side of the cheek parallel in all parts of its surface to the face of the bench front. To overcome this tendency many contrivances have been suggested and brought into use. The most simple means of preserving parallelism between the faces of the bench-front and the cheek of the bench-vice is to be found, perhaps, in the use of a runner of hard wood about 2 in. in width and ¾ in. thick which may either work in a case formed by strips of wood or may pass through a slot cut for its reception in the leg of the bench. In the latter case a series of holes are bored in the runner and when the vice is screwed up an iron pin is inserted in the hole which happens to be nearest to the leg to prevent the further inward progress of the runner. The runner should fit closely, but should work with ease in the case or slot. To effect this, it may be sometimes desirable to apply a little grease.

The chief objections to the ordinary bench-vice in its simplest form are that it takes up a great deal of time to adjust and screw up and unscrew the cheek, and that the pressure exerted by the cheek on the board or whatever else may be placed within its hold, is not uniform at every point of its surface owing to a want of perfect parallelism with the bench-front. As already stated, contrivances have been introduced at one time or other to procure the desideratum of perfect parallelism, but after all there is not one of these that tends to save time by its adoption and use; but rather, on the contrary, some of them cause a still greater loss of time in looking to their adjustment. What is most to be desired, both for working carpenters and joiners and amateurs, is a bench-vice in which the action shall be speedy, the parallelism perfect, and the grip certain, and these requisites are to be found combined in the "instantaneous grip vice" an ingenious invention of which several patterns have in recent years been placed on the market. The principle and action of all vices of this kind are very nearly the same, their

value consisting in the saving of time which is effected in gripping and securing the wood placed between the jaws by just a third of a turn of the hand, and in the force of the grip, which is so great that the wood thus placed remains immovable. When it is desired to grip a piece of wood the rack can be put out of gear in a moment by a slight movement of the handle in an upward direction. The shaft is then pushed inwards until the outermost jaw is brought into contact with the wood and the jaw is then brought to bear on it with great force by a downward movement of the handle. Similarly one-third of a turn upwards releases the work and again leaves the jaw free. These vices are furnished with jaws from 7½ in. to 10½ in. wide, opening to 6 in. and 13 in. respectively. The price is higher than that of the ordinary bench-screw, but it is claimed that the additional cost is more than compensated for by the great saving of time effected. Besides the points that have been already mentioned, the advantages to the amateur in the substitution of the grip-vice for the bench-screw, when making a carpenter's bench, are :—(1) That their attachment to the bench itself is far more easy than the attachment and fixing of the bench-screw, as it involves nothing more than screwing the grip-vice up to the bottom or lower side of the plank forming the front portion of the top of the bench, after notching the edge to a sufficient extent to let in the inner jaw deeply enough to bring its gripping surface flush with the edge of the plank ; and (2) that this simplicity of attachment saves the time, labour and material, otherwise expended in providing for the attachment of the bench-screw, and that the bench may be made without any provision whatever for taking the bench-screw. The top of the bench, however, should be of sufficient thickness to bring its upper surface flush with the top edges of the jaws of the vice. To this end the thickness of the bench top should coincide with the depth of the jaws of the grip-vice. When wood is held between the jaws of the grip-vice it is desirable to interpose pieces of board between the jaws of the vice and the wood, to prevent any marks that might be caused by the direct pressure of the iron jaw. For this reason the jaws are now sent out by the makers with holes drilled ready for the attachment of wood facings when necessary. As the jaws are of iron it is evident that the vice will serve the purpose of an iron bench-vice for holding pieces of metal, as well as that of an ordinary bench-vice for holding wood, and that the amateur who possesses one of these has no occasion to go to the expense of purchasing an iron bench hand-vice. By placing within the

jaws two pieces of wood of sufficient length to hold a saw, this vice may be further utilized as a saw-vice.

The next thing to be considered is the **bench-stop,** against which a board may be fixed during the process of planing its sides. In its simplest form it is a rectangular block of hard wood, about 2 in. square and 8 in. or 9 in. long. The shaded square marked Z in Fig. 7 is a good place for it, because one side lies closely against the end rail on the left of the bench, while against the other side a stop can be screwed to the under side of the bench top; and, indeed, additional stops may be placed on the other sides, so that the depth of the socket in which the bench-stop works may be increased as much as possible. A hole is cut in the top of the bench for the bench-stop to pass through, and into the top of the stop are driven two or three iron nails, the projecting ends of which are filed off to a chisel edge. The stop is moved up and down generally by knocking it at the bottom or at the top, as may be requisite, and when it is down its top should be flush with, or slightly below, the surface of the top of the bench, a groove being cut for the reception of the projecting teeth.

An improvement on this simple form of stop often found in workshops is made by forming two pieces of hard wood, each about 2 in. by 1 in., and 8 or 9 in. long into a pair of folding wedges. A small screw is inserted in the back wedge to prevent it falling through when the front wedge is loosened.

A simple and effective device used by the writer for regulating the height of the stop may be made and fitted to the bench in the following manner. From a piece of hard wood, such as oak or mahogany, about ⅞ in. in thickness, is cut a circle 5 in. in diameter. A hole large enough for a stout screw is bored through this circular piece of wood about 1 in. from the centre, and at this point it is fixed to the leg of the bench immediately below the bottom of the stop, which works freely in the hole cut in the top of the bench and between two long screws which serve as guides in the leg of the bench. Another screw, or a wooden peg, is fixed near the edge of the disc opposite the hole made for the holding screw, and serves as a handle for turning it. The revolution of the circular piece of wood upon the point 1 in. from its centre produces an eccentric motion with a difference of 2 in. between the highest and lowest points reached by the upper edge. As the bottom of the stop rests upon this edge, the stop is moved up and down by turning the disc in precisely the same manner in which the slide valve of an engine is moved by the eccentric on the crank-shaft. When the wheel as a whole is at

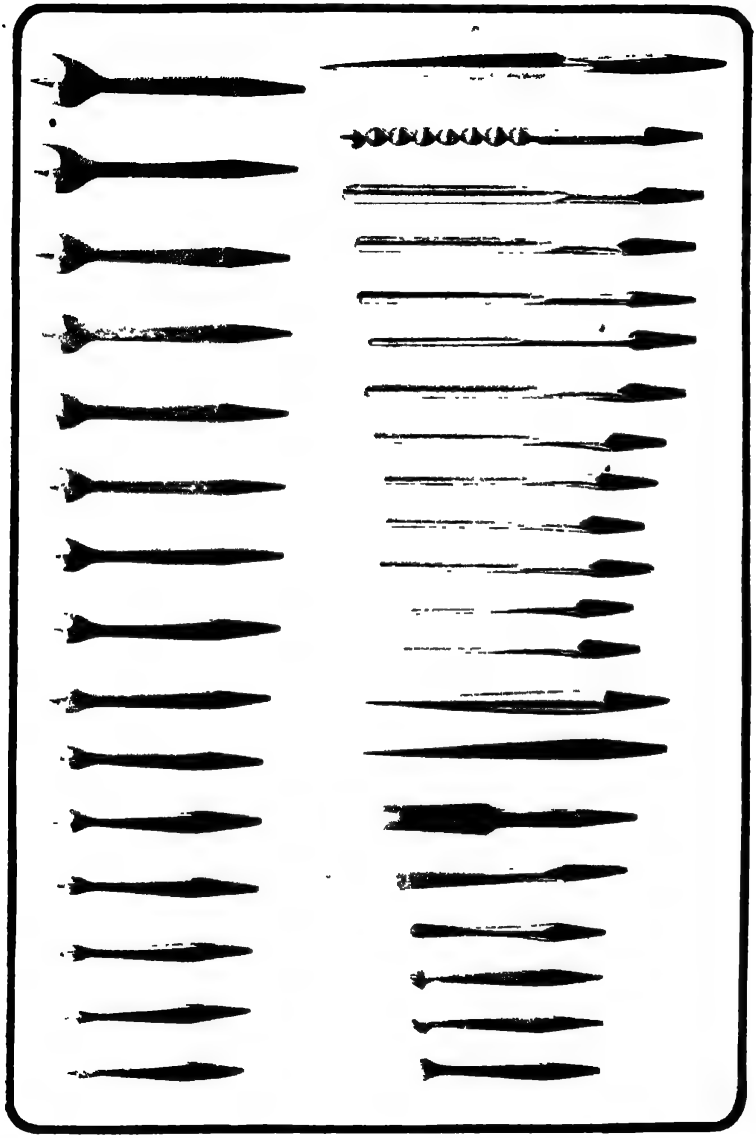
its lowest point the top of the stop should be flush with the top of the bench; when it is highest the stop will project 2 in. above the top of the bench; when the wheel has been given a half turn only the stop will project 1 in.; any intermediate heights can be obtained to a nicety and in the planing of very thin boards this is a great advantage. As the weight of the stop is always directly over the fixing screw, and there is no other downward pressure, the wheel has no tendency to revolve excepting that produced by vibration, and this can always be counteracted by slightly tightening the fixing screw.

There are various forms of iron stops obtainable at the toolmaker's, and although they do not find general favour in professional workshops the amateur, whose work is not of such a heavy nature, may in some cases prefer them to the old-fashioned wooden stop.

The appliance known as the "carpenter's bench-stop" is something like a hinge, and indeed is made on that principle. A hole is sunk in the top of the bench for the reception of the stop, which is let into the wood until its top is level with the surface of the bench. On raising the screw, the part which is attached to the lower part or bed by a hinge joint rises, and presents above the surface of the bench, as shown, a row of teeth against which the edge of the board to be planed is pressed. Thus, with this bench-stop, the inconvenience of knocking the old-fashioned stop up and down to the desired height is obviated, the same effect being gained by a few turns of the screw.

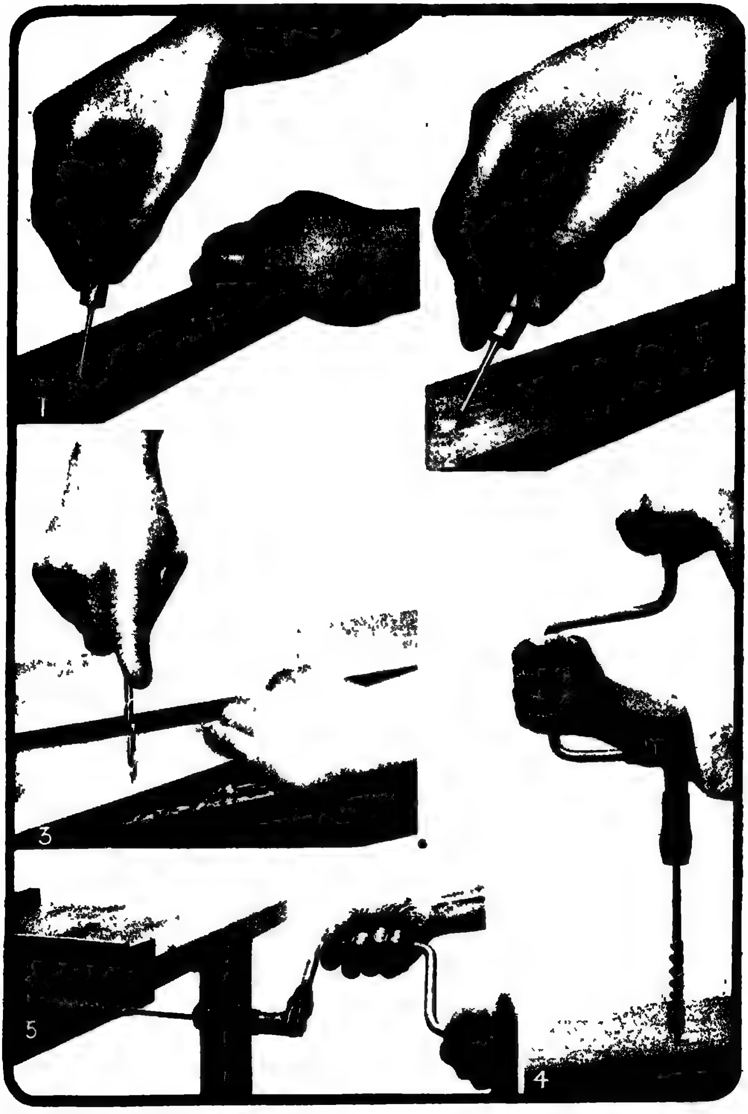
A better form of bench-stop consists of a plate sunk in the bench top and carrying a toothed plate working in a slot cut in the main plate. A hole has to be cut for the reception of the body of the stop in the bench top, and a larger recess in the surface around the first hole to take the top plate, in which are four holes countersunk for the introduction of screws, by which it is securely fastened to the bench top. The shaft of the stop, crowned with a square plate toothed on one side, passes downwards through the body of the stop, from which there is a projection to the left. In this is a contrivance which is acted on by a screw and which, being connected with the central shaft, raises or depresses the stop at pleasure. The stop has no spring, and its action is quick and positive, being operated upon by half a turn of the screw. When set for use it is perfectly firm, in any position, and without vibration in any direction. The shaft, or spindle, and the plate are of wrought steel, tempered to suit the purposes for which these parts are employed. It should be mentioned that the

Plate IX—TOOLS



Sets of assorted brace bits

Plate X—BORING TOOLS



(1) Boring with bradawl, (2) Lifting chip for secret nailing, (3) Boring with gimlet, (4) Vertical boring with brace and bit, (5) Horizontal boring

stop should be fixed so that the end that the screw is in should always be towards the worker.

The **bench-knife** affords, in conjunction with the bench-stop or any stop or peg inserted in the bench in the same manner, a ready means of holding pieces of wood firmly fixed for manipulation, whether by planing or otherwise. The contrivance is a Z-shaped iron knife or stop having a pin projecting from its lower surface, which is dropped into one of a series of holes made in the top of the bench to receive it, the hole being selected which is nearest to that end of the piece of wood to be secured which is the more remote from the bench-stop. Pressure is then exerted on the handle and this acts on a small lever and cam attached to the bed-plate pressing the broad termination of the lower arm into the end of the piece of wood that it is desired to fix. The pressure exerted by the knife or back stop on the wood can only be released by a reverse motion of the handle and as long as it is retained the piece of wood remains immovable. As the row of holes extends along the top of the bench from one end to the other, by altering the position of the bench-knife, wood of various lengths can be secured and fixed against the bench-stop so that it may be operated upon.

Clamps, hold-fasts, shooting-boards and **mitre-blocks** may from some points of view be also regarded as adjuncts of the work-bench, but these have been already dealt with in the section of the work dealing with tools, and for particulars as to their use the reader is therefore referred to that section.

Two useful accessories remain, however, to be considered in connexion with the bench, and these are the **bench-hook** and the **trestle** or **sawing-stool.** In both instances the articles can be made without difficulty by the amateur himself.

The **bench-hook** (Pl. B, Fig 3) may be regarded as a movable stop for sawing light work on the bench without damaging the bench itself. It is formed of a piece of wood about 12 in. long, 6 in. wide and $\frac{3}{4}$ in. thick with a square piece of similar thickness screwed on opposite sides at each end. When in use, the lower stop is placed against the edge of the bench while the piece of wood to be sawn is held with the left hand against the upper stop which takes the thrust of the saw-cut. A sectional view of this useful appliance is given in Fig. 4. The bench-hook is found specially

convenient when using the tenon-saw for cutting shoulders and in similar operations.

The **trestle or sawing-stool** (Pl. II) will often be required by the amateur when ripping down with a saw a long piece of board or quartering or when cutting mortises. The top is a piece of wood about 2 ft. or 2 ft. 6 in. long, 4 in. wide and 3 in. thick, and the legs about 2½ in. by 2 in. or even a little stouter if desired. A notch is cut the upper end of each leg, so that the sides and bottom of the piece top may rest in the notch thus formed, the sides of the notch being at right angles with each other. To afford a better bed or resting-place for the top the sides of the block may be slightly grooved so that part of the leg may be let into the body of block. When four legs of this description have been cut out, and the top grooved, if it be thought better to do so, for the reception of part of the notched ends as described, they must be nailed firmly to the top, two at either end, opposite to one another. To give stability to the trestle, a piece of inch board is nailed to the legs on the outside, and two strips lengthwise from leg to leg, inside. A stool or trestle thus made is very strong, and will bear plenty of heavy blows and hard usage without being damaged beyond the injury that such knocking about may inflict on the surface. The end of the block forming the top is often cut V-shaped, the angle being a right angle, or an angle a little less than a right angle. A notch of this kind forms a convenient resting-place against which to rest a piece of quartering for cutting a tenon at the end. The amateur artisan will find it useful to provide himself with a couple of clamps of the kind shown in Pl. VIII, for holding down to the stool any piece of wood that may require mortising. In fact, a couple of small clamps of this kind will be found useful in many operations in household carpentry and joinery.

PART II

Ornamental and Constructional Woodwork

CHAPTER I

ORNAMENTAL WOODWORK AND ITS VARIOUS BRANCHES

In the preceding section of this work the amateur has been made familiar with the materials and tools used in household carpentry and joinery, he has become acquainted with the processes by which rough wood is cut to desired sizes and shapes, and he has learned to perform the various operations by which the wood is further prepared and framed together. Extensive as may be the field of useful work which such knowledge will enable him to cover, the handyman will naturally desire in due course to proceed from the comparatively simple operations falling within the province of the carpenter and joiner, such as the putting up of sheds and outhouses and the making of tables, boxes and book shelves, to the more ornamental, though still useful, work involved in cabinet-making, which comprises not merely the making of cabinets, but the construction of all the better-finished articles of furniture found to some extent in every modern home. Cabinet-making has rightly been described as the highest branch of joinery. It is distinguished from ordinary carpentry by the careful selection of material by the greater delicacy of manipulation and care required in the use of tools and in the pleasing appearance given to the finished article. Apart, however, from actual construction of furniture there are several minor branches of ornamental woodwork which are particularly attractive to the amateur. These minor branches, which include wood-turning, fretwork, veneering, marquetry and wood-carving, are all closely connected with and may in some cases be considered as forming part of the general work of cabinet-making, but as they require special consideration and

also special tools and appliances it is proposed to deal with them in the present section before passing on to cabinet work itself.

Wood-turning is the art of shaping pieces of wood into cylindrical or other symmetrical forms by operating upon them with cutting tools whilst they are being rapidly rotated in a lathe.

General Principle of the Lathe.—The broad principle of the lathe, or turning lathe, as it is often called, may here be described, the details of its construction and particulars of its uses being reserved for the following chapter. From a strong and rigid frame called the lathe-bed rises a couple of uprights. Of these the one on the left of the worker, which is termed the head stock, is fitted with a mandrel and pulley, while that, on the right, which is known as the tail stock or loose poppet, is bored to receive a steel cylinder carrying the cone centre fitted to the end of a long screw which is actuated by turning a hand wheel or handle at the right-hand end. Between these uprights is held the piece of wood to be turned. On one side of the lathe and beneath the bed of the lathe is a large driving wheel, the axle of which is bent to receive a crank hook connected with the treadle. A cord passes over the circumference of the driving wheel, and the pulley of the headstock, and, by working the treadle, motion is imparted to the wheel and pulley, which is communicated to the wood, which revolves with great rapidity. A tool rest works backwards and forwards along the front of the frame which forms the lathe-bed, and on this, as the name implies, the tool is rested when being used to cut the wood as it revolves. It must be remembered that the foregoing is not so much the description of a lathe as that of the general principle of its construction, how it is set in motion, and how it acts. It is inserted here to give the amateur mechanic some idea of one of the most useful and important pieces of machinery which is used every day in cabinet-making and ornamental carpentry and joinery.

Uses of the Lathe.—From the description which has been given of the principle of the lathe its uses will at once be made manifest. Ornamental bars, columns, legs of chairs, knobs for handles of drawers or doors, pedestals and an infinite variety of such articles can be easily and quickly made. The making of such articles as these involves the use of both the head stock and the loose poppet, as it is necessary to support both ends of the

wood to be operated upon, but in turning such an article as a bread platter or a bowl the wood is held on one side only in a suitable chuck which in its turn is screwed on to the mandrel. It will be noted that the wood to be turned revolves with the mandrel and pulley, becoming, as it were, merely an extension of the mandrel. The screw that passes through the back poppet is fixed and the wood into which it is forced revolves freely about its point. It will also be noticed that the axis of the mandrel and that of the screw in the back poppet must of necessity be in one and the same straight line.

Fretwork.—In fretwork, which consists in cutting out an ornamental design in thin wood by means of a very delicate saw, the amateur may attain excellence with a far less expenditure of time than is necessary in the case of wood-turning and, becoming skilful in this branch of woodwork, he may lend to many articles of furniture or household fittings which are plain in themselves a highly ornamental appearance and character. A familiar exemplification of fret-cutting may be found in the perforated woodwork lined with coloured silk which forms the front of an upright piano immediately above the keyboard. As in the case of turning, the description of the tools and the manipulation required will be reserved for another chapter. Our purpose in mentioning these branches of ornamental woodwork here is merely to point out to the amateur how he may make this handicraft peculiarly useful from a decorative point of view. Fretwork in itself is strictly ornamental in character and can only be applied to decorative purposes. Brackets, paper-cases, book-stands, and a variety of small pieces of ornamental furniture of this kind can be adorned most effectively by fret-cutting; the raised rim that usually surrounds three out of the four sides of each shelf of the whatnot or wagonette, and the thin boards by which the music cabinet is usually divided into narrow compartments may be enriched by this kind of decorative work.

Veneering.—Whilst explaining the first method of dove-tailing (see p. 119) it was remarked that it was seldom used for outside joints unless the outside was to be afterwards veneered. By veneering is meant the laying a thin sheet of valuable figured wood, called a veneer, upon a foundation of common and cheap wood. This is sometimes done to cover and hide joints, but more frequently to give the less valuable wood the appearance of the ornamental wood of which the veneer is made. If done

well it will be very durable, and is an inexpensive way of producing a handsome effect. Of course the larger the article the greater will be the saving : indeed, for very small objects the extra labour will out-balance the saving in material, and therefore such articles are seldom veneered, but made of the solid, valuable wood. Veneers are generally cut from mahogany, rosewood, bird's eye maple, or walnut, but veneers of almost any other sort of wood can be obtained of the cabinet-maker.

Inlaying.—Inlaying is the art of decorating flat surfaces by cutting away the solid wood of what may be termed the ground and letting in thin pieces of different coloured woods or pieces of pearl, ivory, tortoiseshell, or metal which have been cut to the desired shapes by means of the fret-saw.

Marquetry is a form of inlaying with thin veneers. The design, or pattern, is first marked on the veneer which will form the groundwork, and other pieces, sometimes as many as four or five, of different colours are attached to the back of this piece. The pattern is then sawn out of all the thicknesses at one operation and the pieces of the required colours fitted into the groundwork to form the design, the corresponding pieces of the other layers being cast aside. Great accuracy is of course required in sawing to the lines of the pattern, but this is soon acquired by practice.

Intarsia.—As used in its original sense this term refers to the solid inlaying practised in mediæval times in which woods of one or more colours were let into a lighter or darker ground. In its more modern application, however, it is used in connexion with that form of marquetry which aims at producing in wood pictorial effects, such as simple landscapes, seascapes, street architecture and interiors. The striking effects of perspective and of light and shade produced in work of this kind are due more to the judicious choice of woods and the clever arrangement of the grain than to merit in design, whilst the execution itself is extremely simple.

Parquetry.—Although commonly associated with the ornamental flooring formed by the arrangement in geometric patterns of wood blocks, the term parquetry may more properly be considered as applying to all inlaying, whether in wood or other material, in which a decorative effect is produced by the repetition of a definite geometric pattern. Regarded in this way, parquetry is the most ancient form of inlaid work, and many

beautiful specimens in illustration of its uses may be seen in the British Museum and at South Kensington.

Wood-carving.—The highest branch of the art of working in wood is undoubtedly that of wood-carving, for in order to arrive at any eminence in this decorative work it is necessary that the operator should not only have acquired the manipulative skill of the expert artisan, but that he should also possess true artistic feeling and be capable of giving individual expression of that feeling both in form and design. This, of course, does not apply to the ordinary carved work seen on legs of chairs and parts of other household furniture, such as the claws of a round or oval table supported on a central table or even the garish scroll-work in imitation of foliage which sometimes disfigures the frame of a pier glass, but to such examples of the wood-carver's art as may be found in the copies of still life, produced by the chisel of Grinling Gibbons, the elaborate panels and decorations of the famous Kenilworth sideboard, the thrones of bishops in our cathedrals and the carved screens which adorn our village churches. To excel in such work requires time, patience and abundant practice and, as has been said, the spirit and feeling of a true artist. Much, however, may be done in a humbler, less ambitious way and the amateur wood-carver need not despair of turning out work sufficiently good and appropriate for the adornment of his own home. It is, in any case, a pleasant pursuit, and perseverance in the study of any art has never yet failed to bring its own reward.

Carving may be defined as the art of ornamenting wood or stone with design by means of cutting tools held in the hand, and the carver is one who works in wood or stone in such a manner. Whilst, however, the carver in stone, if he attains eminence in his art, is usually termed a sculptor, there is no distinctive name for the carver in wood, and he is only known as such, be his work ever so beautiful and true to nature.

CHAPTER II

THE WOOD-TURNING LATHE AND HOW TO USE IT

The principle of the lathe having already been explained we may proceed in the first place to describe in some detail a simple but efficient form of lathe suitable for the use of the amateur and afterwards to consider the appliances and tools used in turning

and the mode of using them. It must be remembered, however, that in this and the following chapters no attempt is made to lead the amateur to the higher branches of the art of ornamental woodwork. It is sought only to tell him what machinery and tools to buy, and how to use them, and having brought him to the threshold, as it were, of this most pleasing handicraft, to leave him to continue his progress in a branch of constructive art on which volumes have been written without exhausting the subject or even wearing out its freshness.

The Foot Lathe.—A serviceable and inexpensive type of foot lathe which will meet all ordinary requirements of the amateur wood-turner, is shown in Pl. XXI, Fig. 1.

The standards or legs are in this case made of cast-iron; sometimes they are made of wood, but, if of the latter material, they must be made much stouter and stronger than represented. These standards support the bed to which they are firmly bolted, and between them they also carry the crank-shaft and the treadle-shaft. The crank-shaft is made of wrought-iron and works in collar necks and bearings. The treadle-shaft is also made of iron and moves freely in holes made in the standards. Fastened to this shaft is the treadle-board, by means of which the crank-shaft is set in motion. Upon the crank-shaft is keyed a heavy cone pulley or driving wheel. Although the steps of the cone pulley are generally flat and the wheel is driven by a flat leather belt, it is found that for light lathes a V-grooved pulley driven by a round belting of gut or leather is preferable.

The bed is generally made of cast iron, but it can be made either wholly of wood or partly of wood and partly of iron. In the latter case, the top of the bed is faced with iron. Whatever material is used it is essential that the top surface of the bed should be perfectly straight and level and be scrupulously kept so. In order to take work of large diameter such as a wheel or platter, the bed of the lathe is in some cases made with a gap close to the head-stock or the head-stock and tail stock and rest may be packed up with pieces of wood as shown in the illustration.

The head-stock should be made of cast iron. The steps or grooves of the speed-cone should be made to correspond with those of the driving wheel. The cone is keyed to the mandrel, which is made of either iron or steel, and is turned to run in a steel or gunmetal bearing in front of the

cone-poppet. Behind, it is furnished with a conical indent which runs on a steel-pointed centre screw. The other end of the mandrel has a screw-thread cut upon it, and is fitted with a sharp steel point or centre. The centre screw is made of iron or steel, and has a point or centre at one end, and a nut at the other; it screws through the cone-poppet and is kept from either screwing or unscrewing by tightening a lock-nut.

The tail stock or loose poppet is also made of cast iron, and can be moved anywhere along the bed and fastened firmly when and where required by tightening the screw beneath it. Through this poppet there is a hole fitted with an internal or female screw made of wrought iron or steel, cut with a thread capable of receiving the screw which passes through it and has at one extremity a sharp front or centre, and at the other an iron handle. By turning this handle forward the centre or sharp point of the screw approaches nearer the other poppet, and by turning it the contrary way it recedes from it.

The base-plate rest, which is made of iron, can be moved freely along the bed between the two poppets. It has a dove-tailed groove cut along its bottom to receive the head of the bolt by which it is held down to the lathe-bed. It can be moved in or out, nearer to, or farther from, the work. It can be firmly held, where for convenience it is required, by tightening the headed screw which passes through the slot of the bed. This screw is made of iron, and is in two parts; one part has a head the same shape as the groove in the rest-holder, and also has a thread cut upon it to fit into an internal thread cut in the lower part or nut of the screw. The tool-rest is made of iron, either wrought or cast, but generally the former; it has a round shank which fits into a socket in the holder. The rest can be raised or lowered in the socket, and set at any convenient angle; it is firmly fixed at the required position and height by tightening the set screw.

It now remains to show how motion is given to the mandrel, and consequently to the work. The operator stands in front of the lathe generally with his right foot on the treadle-board. The board must be depressed, and directly it comes to the bottom the weight of the foot must be removed from the board. The momentum of the pulley will carry the crank over the "dead centre," and will raise the treadle to be again depressed with greater force until the cranked shaft comes up to speed. The circular motion of the cranked shaft is communicated to the mandrel by leather belting or gut passing over both pulleys.

The cone on the crank-shaft is generally of a much larger diameter than the mandrel cone, the former often being five or six times as large as the latter. This is done to increase the speed: thus, supposing the large cone to be five times the size, or to have a circumference equal to five times the circumference of the mandrel cone, then every revolution of the crank-shaft will make five revolutions of the mandrel. It is generally agreed that one can conveniently, and without great exertion, tread about eighty or one hundred times per minute. The cones are made in steps, so as to alter the speed of the mandrel whilst the crank-speed remains constant; thus, when we wish to increase the speed, or drive at the highest speed, the gut or belt is put on the largest speed of the crank-shaft pulley and the smallest speed of the mandrel pulley; and when it is desired to decrease the speed to a minimum, the belt should be on the smallest step of the crank-shaft pulley, and the largest of the mandrel pulley, the intermediate speeds being similarly obtained.

Wood differs so very much in density, grain, etc., that it is impossible to state the speed at which it should be turned, but the amateur turner need be under very little apprehension of running his lathe too fast. As a general rule, however, it may be observed, that the *best* speed is the fastest at which it can be turned without blunting the tools too much. When a lathe is driven from a shaft by steam or other power, there is more chance of overdoing it with regard to speed, because it is quite possible to drive even so soft a substance as wood fast enough to cut or rub the steel tool instead of the tool cutting the wood. The speed should seldom exceed 500 circumferential feet per minute—that is supposing the article to be 1 ft. in circumference it should revolve not more than 500 times in a minute. This must not, however, be considered as a fixed rule. The amateur, by the exercise of a little observation and judgment, will very soon be able to tell the proper speed for any particular kind of work; indeed, an experienced workman can tell at a glance before touching the work with his tools whether the speed is right or not.

Chucks.—Having obtained the circular motion with the lathe, it remains to communicate this motion to the work. There are several methods of doing this, but it will be sufficient to show some of the best and most frequently used. For the required purpose, various forms of holders known as "chucks" are used and these are screwed to the mandrel.

The **prong-chuck,** so called from the steel prong or fork

which fits into the socket of the chuck, is used for all kinds of work supported between the centres. One end of the wood to be turned is placed against the prong-chuck so that the spike of the chuck is in the centre of the wood and the back centre is then moved along to support the other end. When by gently revolving the work it is found to be truly centred, a few sharp blows should be given with the mallet as so to imbed the prongs of the chuck more deeply into the wood (see Pl. XXII, Fig. 1) and the back centre should be brought forward a little and firmly secured. In order to reduce the friction a small hole should be bored in the wood for the reception of the cone of the back centre, shown in the illustration, and a drop of oil should be put upon the centre point. The centre should be screwed up fairly tight at the outset as otherwise it will work loose when the lathe is running. It is essential that both the spur of the prong chuck and the cone of the back centre should be in the middle of the wood as otherwise it will be necessary to turn off more of the wood on one side than on the other before it is quite circular, and if the rough wood is not considerably larger than the finished article is required to be, it will not hold up to size.

The Taper-screw Chuck.—The taper-screw chuck, shown in Pl. H, Fig. 1, is a very useful chuck; it is used entirely for short work. The chuck, which may be made of either wood or metal, is screwed on the mandrel end, a hole is made in the centre of the wood to be turned of the same size as the smallest part of the screw, and rather deeper than its length; the hole is applied to the point of the screw and the work held held firmly whilst the lathe is pulled round slowly with the left hand. The wood will then be screwed up against the flat surface of the chuck, and will remain there firm enough to be turned. If it is wished to screw the work on the opposite side, so as to be able to manipulate the unturned portion, a hole similar to the one already made must be cut out in this side whilst the work revolves. The wood can be then unscrewed and put on the other side. If this hole be cut or turned out true, that portion of the article which has already been turned will run true when the sides have been so changed.

The Split Chuck.—The fault in the taper-screw chuck is that the screw disfigures and injures the face of the work. For some things, such as patterns, this is of very little consequence, because the holes thus made can be stopped with putty; but for ornamental

articles these marks or disfigurations would often be very objectionable. Therefore, when the amateur artisan has occasion to turn anything of that sort, if small, he should use the split or spring chuck, shown in Pl. H Figs. 6 and 7. The article can generally be partly turned more conveniently in one of the other chucks, and such portions in them as cannot be done without injury turned in this one. The split chuck can, however, be used for many other purposes.

Face-plate.—If the article is large, the face-plate shown in Pl. H, Figs. 4 and 5 is screwed on to the mandrel end, and the article stuck to the plate with cement.

The following recipe will be found useful in making a good cement for this purpose. Take of resin four parts and of pitch one part; set these ingredients by the fire to melt in an old pan or earthen pipkin, and when the mixture is liquid stir in sufficient finely powdered brick-dust to make it a stiff paste.

The cement must be placed hot on the face plate and the work pressed against it, care being taken to ascertain that its position is perfectly central. When cold it will hold the wood sufficiently firm for the article to be carefully turned; and, when finished, a gentle blow will detach the work from the plate. The cement must be laid evenly on the face plate, and must not be thicker in one place than another, otherwise the article when faced up will be of unequal thickness.

Another method of holding work in the lathe without injury to its surface is to screw a piece of common wood to the screw chuck or face plate, in the ordinary way and in this piece of wood to turn a recess or cavity of such a size that the article which it is desired to turn fits into it tightly. If practicable the back centre should be brought up so as to support it, but when this cannot be done and the surface of the work is so smooth that it revolves in the cavity when the cutting tool is applied, a little soft chalk should be rubbed both about the chuck or recess and that portion of the object which fits into it.

Although the wood turner uses other chucks for special work, the amateur artisan will find that, with proper management, those already described will be sufficient for all his purposes. The chucks used for iron and brass turning are quite different in character from those described, but will be found to answer well in many cases for ornamental wood turning.

Home-made Chucks.—Although the different chucks to which reference has been made may be obtained in iron or brass, the

amateur mechanic may, without difficulty, make them for himself of hard wood such as box or beech. Other suitable woods for the purpose are sycamore and bass.

In some respects wooden chucks are better than iron ones, but they are not so durable. If, in turning, the tool comes in contact with a metal chuck, the cutting instrument gets the worst of it; but if the same thing occurs with a wooden chuck, the chuck itself will be damaged.

Turning Tools.—The tools used by the ornamental turner are very numerous, but one or two different sizes of the gouge, flat chisel, diamond point, and cranked tool will do for a great variety of work. In fact, the amateur artisan is strongly advised to commence with these only, and not to get others until he finds that he really requires them.

The Gouge.—The gouge is shown in Pl. XXIII and XXIV, the former showing its appearance at the front and the latter at the side. It is used for "roughing down," or taking off the bulk of the superfluous wood, and for turning out hollows and curves that cannot be conveniently done with a chisel, and when the user of this tool has had a little experience, it may be used for squaring down the end of the article. For the first two purposes it is laid on the rest with the round side downwards, and in such a position the cutting part is rather above the centre of the work. The manner of holding the gouge in this operation is shown in Pl. XXIII, Fig. 2. For the third purpose it must be held on its side and turned over in the process of cutting till the hollow side is downwards (Pl. XXIV, Fig. 4).

The Chisel, shown in Pl. XXIII, Fig. 1, is used for smoothing the work after it has been roughed down by means of the gouge. Inexperienced turners generally hold this tool with the cutting edge *parallel* to the surface of the wood. In this position it acts as a scraper and causes a roughness on the work which is a sure sign of a slovenly workman. The proper position for holding this tool is with its cutting edge obliquely to the surface, as shown in the illustration. When held in the manner indicated a much smoother surface is obtainable, and the tool does not require sharpening so often as it does when held wrongly.

The Diamond Point or Graver is used for roughing down small or delicate work which will not bear the gouge being applied to it or heavy cuts being taken off. It may also be used

for finishing off sharp angles and for internal work and recesses where the other tools will not conveniently enter. For the purpose of roughing down, the point only should be used; for other work, both the point and sides come into operation. The point should seldom, if ever, be held above the centre.

Parting Tool.—For cutting off finished work from the block from which it has been turned a parting tool, is used. It is about three quarters of an inch in width and one eighth of an inch in thickness. In order that the tool may clear itself as it cuts its way through the wood the back is ground somewhat thinner than the cutting edge.

Boring and Recess Tools.—For hollowing out ordinary work, such as chucks or egg-cups, the gouge may be used. When however any portion of the interior is either irregular or larger than the opening, boring tools of special patterns are required.

Position of Tool-rest.—The position of the tool-rest must be altered to suit the work. As a general rule, the top of the rest will be slightly higher than the centre of the work, but this will be regulated to some extent by the height of the worker. It is important to remember that the nearer the rest is to the work the greater is the command over the tool. To get it sufficiently close, it will sometimes be necessary to place the rest at the same angle as the lines of the work, but in whatever position it may be placed care should be taken that it is firmly fixed.

Callipers.—When turning work down to a definite size it is necessary to have some means of measuring it. For this purpose callipers are employed, those of the form shown in Pl. XXIII, Fig. 3, for outside use and those of the form shown in Pl. XXIV Fig. 3, and for testing the diameter of holes.

Tool Sharpening.—The importance of keeping a keen edge upon all cutting tools and the methods of sharpening tools have been dealt with in the previous section of this work. It may be well, however, to mention here that in lathe work even more than in other branches of wood-work it is essential that tools should be maintained in good order. Defects in amateur work are undoubtedly due more to the use of blunt tools than to any other cause.

Finishing and Polishing.—After the required size and shape

have been given to the article, unless it has been very well done and with exceedingly sharp tools, a sheet of glass paper should be held against the work as it rapidly revolves. This will smooth it and take out any little roughness or tool mark. If the article is a pattern for a casting in metal, so far as the lathe is concerned, it is finished; in other cases, a little oil is often poured upon some fine shavings, and these are applied to the surface; this will greatly improve its appearance. Articles which it is intended to French polish can be done much better in the lathe than by hand.

A large soft pad should be used and at first the work should be revolved somewhat slowly. Afterwards the speed of the lathe may be considerably increased. The work should then be laid aside for about twenty-four hours and the process repeated. A brilliant surface may be finally obtained by going over the surface in a similar manner, but using methylated spirit only. In "spiriting off," as this operation is termed, care must be taken that the pad is not allowed to remain in any one position, but is kept constantly moving. It is also important that it should not contain too much spirit as otherwise the effect will be merely to take off the gloss already obtained.

Where it is desired that the polish should not be too glassy, as when working in dark walnut or oak, a beautiful finish may be obtained by coating the work with a warm solution of beeswax and turps and afterwards working it off first with a stiff brush and afterwards a soft linen rag.

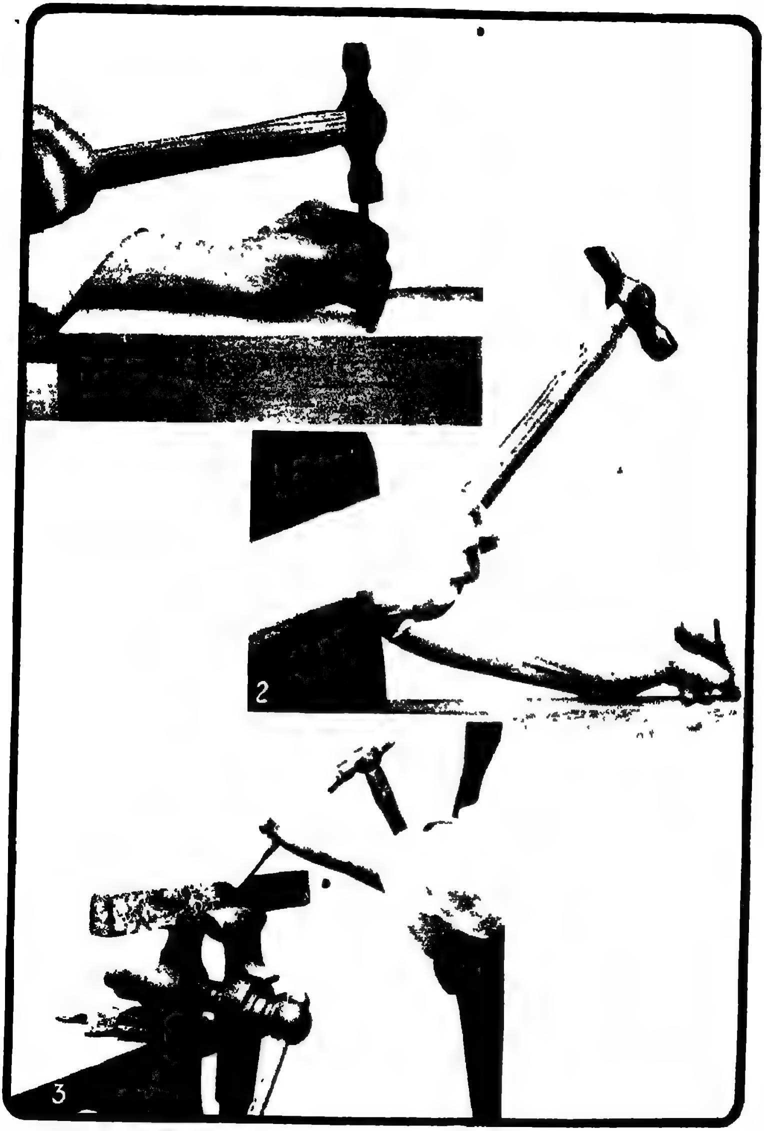
Experimental Work.—Before the amateur turner tries his hand on work which may be subjected to criticism, he should put some rough wood in the lathe and commence operations upon that. He should next turn his attention to those things which, although they are better done well, are not spoiled if done in an indifferent manner. He may, for example, require some tool handles of various shapes. The handles for turning tools should be about 10 in. or 12 in. long and about 1 in. and a quarter in diameter at the largest part; the ferrule should be about three-quarters of an inch. For other tools they should be made of several sizes, from 3 in. to 4 in. in length, with a ferrule ranging from a quarter to three-quarters of an inch in diameter. The rough wood is put into the lathe and turned down for the desired length to the largest diameter. The end nearest the back centre is next turned down to such a size that the iron or brass ferrule can be hammered on tightly. The remaining portions can then be

shaped and finished. The centre mark at the end upon which the ferrule is placed will be no disadvantage, but will serve as a guide when making the hole to receive the tang of the tool. At the other end, however, where the marks of the prong chuck would be a disfigurement, a small length of spare wood should be left. This end should be turned down with the chisel as far as is possible without risk of breaking and when the work is taken out of the lathe separated from the rough wood by means of a fine saw and any roughness removed with glass-paper.

As a further exercise in turning, the amateur may do some very useful work by making a complete assortment of wooden cup chucks. The best wood for the purpose is box, and pieces of this material of various sizes and roughly turned to shape are obtainable at most tool shops.

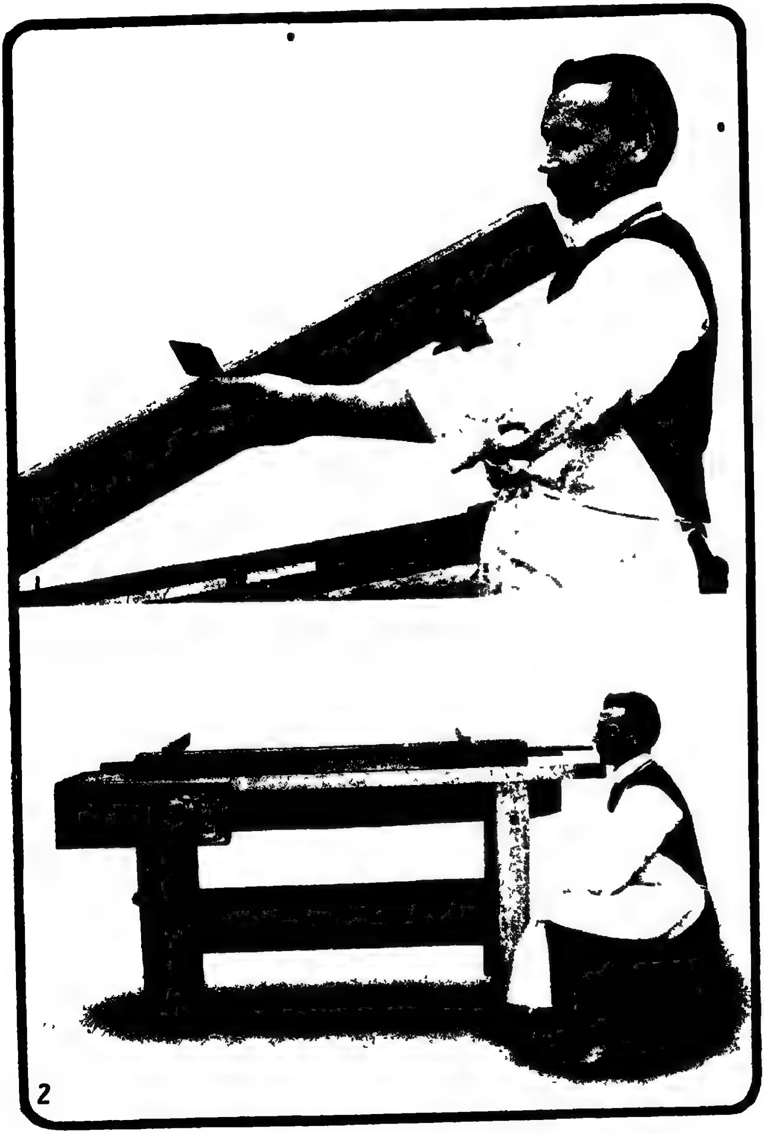
Some useful forms of wooden chucks are shown in Pl. H. Using the taper screw chuck to hold the rough block of wood, one end of the block should be faced up and a hole bored slightly smaller than the nose of the mandrel. By means of the screw taps represented in Figs. 8 and 9, a screw should be cut in this hole of the same thread and pitch as that on the mandrel. The taper tap is used in the first place to cut the thread, and the plug tap is afterwards run through to clear it and give it the full size necessary to ensure that the shoulders bed firmly on the face of the mandrel. When this has been done the work may be removed from the lathe and screwed directly on the mandrel. The rough block may then be trued up and recessed to the required size. In order that a better grip on the work may be secured the recess may be very slightly tapered. It may be mentioned that rough castings of cup chucks of various sizes may be obtained in brass and that the manner of turning these up is in every way the same as that already described in the case of the wooden chuck. Fig. 3 shows a "master" chuck, preferably made of metal, for holding smaller chucks which can be fitted into it without the necessity of boring and tapping each one to fit the mandrel nose. It is particularly useful for the purposes of drilling. The shank of each drill or boring bit should be fitted with a small block of hard wood made to fit tightly into the recess of the master chuck and the drill or bit is then ready for use whenever it may be required. Figs. 6 and 7 show a form of cup-chuck in which a certain range of opening is obtained by slotting the front end with a fine saw. The object which it is desired to turn when forced into this chuck is held with a very firm grip. This pattern

Plate XI—USE OF TOOLS



(1) Using a nail-set, (2) Manner of holding hammer, (3) Chipping iron

Plate XII- TESTING WORK



(1) Testing with try square. (2) Use of winding sticks.

will be found of service also for inside use as when turning a curtain ring or the bowl of a pipe. A bell chuck for holding and centering work of irregular form is shown in Fig. 2. In order that the screws may not damage the work and may have a better hold upon it the points should be filed off and the ends slightly rounded.

As further exercises of progressive difficulty upon which the amateur may try his hand, may be suggested a set of draughtsmen, a set of egg cups and a watch-stand. If he can manage to turn out any one of these in a fairly workman-like manner, he may rest assured that he is sufficiently advanced in the art of wood turning to carry out any work of this kind which he may be called upon to do in connexion with the ordinary repairs of a household. The chief object of this book is to help the amateur to do really useful work; the higher branches of turning will require far more time and devotion than the majority of amateurs are inclined to give to any particular form of handicraft. Those, however, who desire to proceed to the execution of more difficult work will find detailed instructions for every kind of turnery in the numerous treatises that have been written on this subject.

CHAPTER III

FRETWORK

Decorative wood-working may be roughly considered as being divided into two branches, namely, Fretsawing and Carving. Either of these may be carried out independently of the other, and indeed are so, generally speaking; but carving is often combined with fretsawing to give relief to a surface that would otherwise be plain. It can hardly be said that the reverse takes place, namely, that fret-sawing is used to heighten the effect of carving, although the effect is gained in the elaborate tracery of the old oak screens still to be seen in many of our old parish churches. Fretwork is of necessity light and open, whether it be finished with carving or not; but carving is for the most part massive and solid; whilst fretwork consists chiefly in cutting out an open and elaborate design in thin wood, carving is cutting and hewing a solid, or at all events thick and substantial, piece of wood into the semblance of some natural object or some conventionalized or purely imaginary form.

Some of the uses of fretwork as applied to the decoration of articles of furniture have been indicated in the previous chapter. In recent years, however, there has been a very general extension of this method of ornamentation to the structure of the house itself, both externally and in regard to the interior fittings. The great difference in the style and appearance of the modern villa and houses built twenty or thirty years ago is often due to a large extent to the lightness and grace which is given to it by the free use of fretted woodwork. The principal interest which the amateur will find in the larger work which ornaments the exterior of houses will be in the suggestions which it offers for the similar treatment of smaller structures such as summer-houses, green-houses and garden-screens which he may erect for himself. A glance through one of the interesting catalogues issued by the various joinery firms whose advertisements appear in the technical journals will show a large number of designs of fretwork which would enable the amateur at a comparatively small cost to add greatly to the attractiveness of any work of this kind upon which he might be engaged. These include designs of barge-boards used for outlining the ends of roofs and porches; patterns suitable for use as cresting or the decoration of other horizontal lines; crestings for greenhouses or summer houses; and valances for porches and verandahs. Another use for commercially made fretwork is found in the construction of bazaar and exhibition stalls, an infinite variety of work of this kind being obtainable. A good deal of this work is suitable also for the interior decoration of the home by means of grilles or arches, ventilating panels or friezes; and ornamental shelf and porch brackets. Various patterns of fretsawn balusters are now used to produce a light and artistic effect. The production of this class of fretwork at the low prices at which it may now be obtained is due chiefly to improvements in modern machinery and to the introduction of processes by which large quantities of work can be turned out in the same time as that formerly required to make the single article. Much of the work would be quite beyond the ability of the ordinary amateur to execute, but, on the other hand, there may be many occasions upon which he, equally with the modern builder, may avail himself of the facilities offered by its commercial production, either for the purpose of special constructions or merely for the decorative treatment of what is otherwise his own work, and it is with this view that it has been brought to his notice in the present chapter.

The class of fretwork with which the majority of amateurs are

more particularly concerned and which we therefore propose to treat in greater detail is that into which falls the making of various beautiful and useful ornaments by cutting out a design or pattern in thin wood or other material by means of a very delicate saw, and when necessary fashioning together the separate parts thus cut. The great popularity which this form of handicraft has attained within the last twenty years is due chiefly to the recognition of the fact that of all home pastimes, fretwork is the one by which excellent results can be obtained with the least expenditure of time and money. Whilst wood carving is undoubtedly more artistic in character, and carpentry and cabinet making more useful, in the one case much practice is required before skill can be obtained and, in the other, the cost of the necessary tools and need of some kind of workshop must deter many who have little time or funds to spare from adopting them as recreations. Fretwork on the other hand is both inexpensive and easily learned. A complete outfit of tools and appliances may at the present day be purchased for a few shillings, suitable wood, perfectly prepared for cutting, may be obtained at a very moderate cost, and with the various excellent journals dealing with this branch of woodwork the amateur may obtain the best work of experienced designers and instruction by recognized experts in every phase of the handicraft.

For some time, at any rate, the amateur fret sawyer will confine his attention to working in wood. Other materials, however, may be used besides wood. Aluminium, silver, copper, brass and, in fact, any metal which is not as hard as the saw-blade itself can easily be cut, as also ivory, bone, xylonite and suchlike materials.

It is with fretsawing in wood that we have to deal at present, but with regard to working in other substances, it may be useful to point out in cutting metal there is a much greater degree of friction when the material is brought under the action of the saw-blade and, therefore, a different speed must be given to the saw and the operator must remember to equalize that friction by reducing the rate of speed.

Fretwoods and Woods used in Ornamental Work.—For the use of the fretworkers specially selected woods may be obtained, well seasoned, planed to thickness and perfectly ready for use. Fretwood is sold by the square foot of 144 square inches. As the boards from which the required pieces are cut are not always 12 in. in width, some being narrower and some wider, the length

in any quantity supplied to order will depend upon the width. If, for example, 3 square feet are ordered, and the width of the board is only 6 in. then the length supplied will be 6 ft. If on the other hand the board is 18 in. wide, the length will be 2 ft. If the wood is 12 in. wide, the length will, of course, be 3 ft. The worker who lives away from a town and therefore orders his wood by post will do well to accustom himself to this method of measurement.

The thickness of the prepared wood varies from $\frac{1}{16}$ in. (for thin overlay work) up to $\frac{1}{2}$ in. The average thickness is about $\frac{3}{16}$ in. and this will prove the most useful for all ordinary designs. For lighter work, such as small frames and boxes, $\frac{1}{8}$ in. should be used, whilst for large and bold work $\frac{3}{8}$ in. or sometimes $\frac{1}{2}$ in. will be required. The rarer kinds of wood, such as holly, satinwood, rosewood, and ebony are expensive, but the price depends largely upon the thickness of the wood and its quality. By comparison with the cost of ordinary wood, the charges made for fretwood may at first sight appear high, but it must be remembered that in fretsawing a little wood will go a long way, and that the amateur has the advantage of obtaining his material ready for use, and of a uniform gauge as regards thickness. Some of the woods are by no means easy to work, or smooth with the plane, and this fact alone will go far to convince the amateur that he is really getting his material at a reasonable rate at the prices charged; especially when it is further taken into account that the wood is, in every case, sound and good and well seasoned.

Apart from the consideration of appearance, the selection of the kind of wood to be used for any particular piece of work will be influenced by a knowledge of the differences of grain and a study of the pattern to be cut. In some woods, the grain is close and compact; in others it is open; in some cases, the wood is hard and difficult to work, while in others it yields easily to the saw; some kinds, again, are so tough and elastic that the most delicate tracery may be cut in them without fear of breaking, while others are extremely brittle and require the exercise of the utmost care

The general characteristics of several of the woods suitable for fretwork, including mahogany, walnut, ash and oak, have been dealt with in the first section of this work Other kinds of wood which the amateur fretworker may at one time or another find useful, and which it will be convenient to deal with generally in the present chapter, are the following.

Birch.—The wood of the birch tree is light in colour, firm and tough, and easily worked. It is used especially in northern countries for making wheels, for cooperage and also for turnery. In America the wood of the Black Birch is considered valuable for cabinet making and for household furniture, and in this country is often used for bedsteads, small tables and other furniture. For fretworking purposes it may be obtained either in prepared boards of the usual thickness or as three-ply wood. The latter consists of three layers, each $\frac{1}{16}$ in. thick, glued together under great pressure, with the grain of the inner layer running at right angles to that of the two outer layers. This process gives the finished board great strength and pliability, so that it is sometimes described in commercial lists as "unbreakable." The advantage when used for fretwork is that the arrangement of the grain permits of fine points being cut without danger of breaking.

In connection with three-ply-wood it may be useful to mention that it may also be obtained in other varieties of ornamental woods such as walnut, mahogany, bird's-eye maple, figured oak and padouk.

Chestnut.—The wood known as chestnut is derived from two widely different kinds of trees—the Horse Chestnut and the Spanish or Sweet Chestnut. The wood of the Horse Chestnut, which is white and brittle, is used by turners for fancy work, whilst the wood of the Sweet, or Eating Chestnut, is hard and durable and beautifully grained and variegated. Furniture is sometimes made of this wood and it is used with effect for decorative purposes in building. The variety used for fretwork is the white chestnut. It is a beautiful wood, almost equal to holly, and is easily cut.

Ebony is a fine, heavy and compact grained wood which can be worked without difficulty. It is much used by mathematical instrument makers, for fine cabinet work and in the manufacture of musical instruments. Ebony is distinguished as Green and Black. Green Ebony comes from the West Indies and is so called from the colour of the heart wood, which is a brownish-green. It is frequently used in marquetry. Black Ebony is brought from Africa, the East Indies and the Island of Mauritius. African Ebony is a serviceable wood and stands well, but the colour is indifferent and the wood porous. The Ebony from Mauritius is very hard, of fine close grain and of a deep black colour, and being the best of the three is the most expensive.

The Black Ebony of Mauritius and the East Indies affords the best and most direct contrast to white holly in marquetry, a handicraft which may be regarded as closely allied to fretwork. Sawing ebony is a somewhat dirty business, as the dust soils and blackens everything on which it falls, and especially any surface upon which it is rubbed. The material cuts clear and fine as ivory and is therefore specially suitable for use in marquetry. It will not warp readily, but is apt to split under changes of temperature; its want of elasticity renders it inclined rather to break than to bend, but its fine close grain admits of a magnificent polish and a handsome appearance may be given to it by mere oiling. As it is seldom more than 6 in. wide, only small articles can be made of it in one piece, but for small ornamental work it is very suitable. A smooth surface can easily be produced upon it by means of the tool known as the cabinet scraper (see p. 60).

Prepared for fretworking purposes, ebony is a very expensive wood, the price varying according to the thickness. In recent years successful imitations of ebony have been produced by staining to a deep black various hard woods such as holly and beech. As the grain of the wood is stained through the entire thickness of the wood all the edges are quite black. These imitations, which are now very generally used by fretworkers, have been placed upon the market at about one half the price of the real ebony.

Holly.—Holly cannot be obtained of any great size in the United Kingdom. It is beautifully white, hard, close-grained, and durable. For these reasons it is very useful for turning, carving in wood, and especially for inlaying. The Holly attains considerable height and growth in America, and broad boards or sheets of wood, suitable for fretcutting and marquetry, are sawn from American holly trees. The wood obtained from the American holly is known as *White Holly*, being pure white—more so than most ivory—and quite tough. The whiteness is due to a particular mode of seasoning, the wood being cut into marketable sizes and steamed or boiled for a few hours and then stacked and carefully covered up so as to ensure a slow and clean drying. Subsequent exposure gives it a mellow creamy tint. The grain is very fine and close, and does not readily absorb foreign matter. It may be protected by a coating of bleached shellac, but the general effect is injured, if not entirely spoilt, by any preparation that tends to impart to

the surface a shiny appearance. The wood is apt to split and warp unless seasoned with care and kept in a dry place. It is hard and difficult to work. When White Holly becomes discoloured or dingy it may be easily cleaned up with a bit of chamois leather dipped into clean dry paris white; and its whiteness may also be restored by rubbing it carefully with very fine sandpaper.

Lime or Linden.—The lime is familiar as the lopped and trained tree commonly used in suburban roads to form a screen between the dwelling houses and roadways. For this purpose the trees are planted fairly close together and the principal branches either interlaced or brought towards one another. The wood, which is of a pale yellow colour, is soft, light and easily split. It is not very durable. It is easily worked and is very free from knots. For this reason it is a popular wood with carvers. Lime is also used for toy-making and turnery. As it is not liable to warp, it is specially suitable for sounding boards and for other parts of musical instruments, and is often utilized for this purpose. It may be obtained as fretwood, but owing to its softness will be found unsuitable for other than bold designs.

Poplar.—The wood of the poplar is white, soft and brittle, and is chiefly used in the manufacture of children's toys. On account of its softness, horizontal sections of the tree are often used by glass grinders and lapidaries as polishing wheels. The wood of the poplar is not liable to shrink, warp or swell. The fret-worker will find it useful for backgrounds, linings and veneered work.

Rosewood.—The best rosewood, so named on account of the fragrant odour which the oil or resin it contains gives to some varieties, comes from Rio Janeiro; an inferior quality imported from the East Indies is known as the "Blackwood" of India. In colour it is dark brown, being the darkest of all woods except ebony. It is hard and difficult to work but when brought to a good surface and well polished, it has a very handsome appearance. It is used by the cabinet maker for ornamental furniture and by the turner. It is also useful for inlaying and veneering. The knots which occur in it tend to diversify the surface and can be turned to good account by a skilful workman. The wood contains much resinous gum and on this account it is difficult to saw when used for fretwork. This hindrance may,

however, be overcome by slightly oiling the saw-blade now and then in order to lessen the friction. A still better method, and one which will prevent the staining of the work, is to use a piece of wax candle for the purpose. There is an African variety of rosewood, beautifully marked and bearing a strong resemblance to black walnut, which is free from the resinous gum so abundant in the ordinary kind. Used as fretwood, rosewood ranks amongst the most expensive variety.

Amboyna Wood is a beautiful and valuable wood of diversified appearance, deriving its name from Amboyna, one of the Molucca Islands. It is sometimes called "Lingoa" wood. The colour varies from orange to chestnut brown and sometimes reddish brown. The wood is very hard and durable. It is used in inlaying and occasionally for veneering. It has the appearance of being the burr of some large tree, being closely figured with spots and mottles, curled and matted together. The burrs are highly prized and are extremely costly.

Maple (White).—The wood of this tree, commonly known a the Norway Maple, is white, hard, close-grained and tough It is very serviceable as a fretwood as it is inexpensive, easily worked and not easily soiled. It takes a fine polish. It is also used largely for turnery and cooperage.

Bird's-eye Maple is, a very fine variety of maple, brought chiefly from Eastern North America. The wood is yellowish-white in colour, diversified with streaks and dark spots with a lighter ring round them. These spots, from the appearance of which the wood takes its name, are small projections in the surface caused by the fibres of the wood being compressed into spines which occur in the bark. Bird's-eye maple was at one time used for the best furniture but has now fallen out of fashion for this purpose. At the present day it is used chiefly for interior work in shipbuilding and for picture frames. It is, of course, veneered on some other wood and this tends to keep it from warping and splitting which it is otherwise very apt to do. Being a close-grained, gritty wood, it is difficult to work with the hand fretsaw and, even with a treadle machine, the small knots drag on the saw and cause it to run unevenly.

Cedar.—There are many kinds of wood included under the name of cedar, all of which are obtained from cone-bearing trees, or trees of the fir kind. The various kinds are widely different

in qualities and characteristics. The wood of the Cedar of Lebanon is reddish and full of a fragrant resin; it is soft and light and apt to split in drying. The wood of the *Deodar*, or *Himalayan Cedar*, is resinous, fragrant, compact, and durable, and capable of taking a high polish. When polished it has an appearance resembling that of brown agate. The cedar the wood of which is most commonly used is a variety of the Juniper which belong to the Pine tribe. *Red Cedar* and *White Juniper*, indigenous trees of North America, hardly differ, except in colour; but the wood of the former is undoubtedly more handsomely marked and diversified, and being scarcer than the latter, commands a higher price. Both woods take a beautiful polish; but they are resinous, and therefore difficult to cut, requiring at all times careful handling lest they split and break. *Spanish Cedar*, a cedar of the south of Europe, also called *Bermuda Cedar*, is soft, fragrant, and easily worked, though brittle, and is used in making the better class of cedar pencils.

The wood called **Cedarwood** must not be confounded with the true Cedars described above. It is obtained from a tree growing in the West Indies and Central America, to which the name of *Barbadoes Cedar* is given. The true Cedars belong to the natural order *Coniferae*; but this is a tree of the natural order *Cedrelaceae*, which also includes the trees that yield mahogany, satinwood, and the yellow wood of New South Wales. Havannah cigar-boxes are most commonly made of it. It is coarse in grain, very porous, and therefore not suitable for fretwork sawing, though it is useful for lining boxes, and a variety of small cabinet work. Like mahogany, it is not liable to warp. It can readily be stained; but from the coarseness of the grain does not take either oil or polish well. This wood is sometimes called Spanish Cedar, which name, as shown above, truly belongs to the wood of the Bermuda Cedar. In America it is generally so called.

Cherry.—The heartwood of the Cherry Tree is hard and fine in texture, and of a pure reddish-brown colour. It is hard, close-grained and capable of taking a high polish, and is useful for turning and all kinds of fancy work.

Kingwood.—Kingwood is a hard and durable wood, brought from Brazil. It is used in turning, inlaying, and small cabinet work. It is beautifully streaked in tints of violet, for which reason it is sometimes called *Violet Wood*.

Laburnum.—Laburnum is a hard, solid, heavy wood, useful for ornamental turning and marquetry. The heartwood is of a rich brown colour, diversified by large white medullary rays, which show out conspicuously, like the medullary rays of wainscoat oak.

Lacewood.—(See **American Plane.**)

Olive Wood.—Olive Wood, which is imported into this country from the eastern shores of the Mediterranean and from India, is of a close, fine grain, beautifully variegated with curls and knots, and suitable for fretwork, turnery, carved work, marquetry, and all kinds of ornamental cabinet-work. It is easily cut, and of an oily nature. Its variegated appearance renders it a desirable wood for veneering.

Padouk.—This is a very beautiful variety of wood imported from Burma, Andamarn and the Phillipine Islands. It is also known as "Burmese Rosewood" and "Indian Mahogany." It is of a dark reddish tint, somewhat resembling that of Spanish mahogany, but is marked longitudinally with streaks of a somewhat darker hue than the ground colour and also with others which are much lighter. When moved in the light, the effect of this marking is to produce a sheen, something like that of shot silk. The wood is heavy and hard. Though coarse grained it is easy to work. When obtainable in good quality it is one of the finest woods for fretwork. The dark red variety is, however, very rarely obtainable, and any opportunity of acquiring a board of good quality should be seized by the amateur even though he may not desire to put it to immediate use. In order that the beauty of the wood should show to the best advantage the surface should be left plain. If well rubbed with a piece of the finest glass paper and afterwards with a chamois leather it acquires a dull gloss which looks much more handsome than a bright polish.

Plane.—There are two species of plane tree known to commerce, the Eastern plane, the variety which is so commonly seen in the streets of London and which may easily be recognized by its peeling bark, and the Western plane, which has been introduced into this country from America.

The wood of the first named species is of a yellowish colour and is not unlike beech, though considerably softer and lighter.

The grain is fine and close, but the wood is apt to warp and split, and is not very durable. It is sometimes used as a substitute for beech in furniture making and joinery.

American Plane.—The wood resembles that of the Eastern variety, both in appearance and grain. For use as fretwood it is cut radially, i.e. in the direction of the medullary rays. A densely mottled figure is thus produced. In this form it is known as "Lacewood," a wood which in recent years has become very popular. It is easily sawn and is very effective in patterns where a good deal of plain surface is left.

Satinwood, which takes its name from its soft and lustrous appearance, is of a yellowish tint. It is hard, close in grain, satiny to the touch and finely figured with zigzag flashes which have a beautiful appearance when polished. It works well and on account of its colour and natural gloss forms an appropriate groundwork for marquetry and inlaying. It is also a useful wood for veneering and fretsawing. Owing to the natural oil which it contains it is difficult to attach it to another wood by glueing. It does not warp or split to any extent, and by reason of its colour, forms a handsome and agreeable contrast to ebony, tulip wood, rosewood, and other woods of a dark colour. It is brought from the East Indies.

Yew.—The Yew is an evergreen tree of the genus *Taxus*, allied to the pines. The wood is hard, tough, elastic, and durable. In colour it is of a rich chestnut brown. It takes a high polish and shrinks very little. It is generally considered to be the most beautiful of English-grown timbers. The burr is very beautifully figured and mottled and is highly prized as a veneer. In the solid it is used chiefly for turnery and is sometimes stained to imitate ebony. In olden times it was much used in England for making bows. Fine specimens are often to be met with in country churchyards.

The list of woods used in ornamental carpentry may appear to be fuller than is absolutely necessary, inasmuch as many of them may never be handled by the amateur artisan. But though he may never use them, or even see them, it seems desirable that any one who aspires to be a worker in wood should have a general knowledge of the nature, properties, and special uses of the various kinds of woods used in the constructive arts; and with this view, the list that has been placed before the

reader has been compiled. Even now it is by no means exhaustive, but it contains a description of nearly every kind of wood that is likely to come under the notice of the amateur.

Tools and Appliances.—In dealing with the necessary tools and appliances it will be well in the first place to consider the special saw-blades used in fretwork. From these we may pass on to the various forms of frames in which the saw-blades may be held, and afterwards to the description of a simple saw frame and treadle machine and other apparatus useful in the prosecution of the art.

The saw-blades used in fretwork are about five inches in length and are made of delicate steel wire with correspondingly fine teeth. They are very cheap, being commonly sold by the dozen, although when purchased by the gross may be obtained at a considerable reduction. They are supplied in ten different grades, numbered from 00 to 8, proceeding from fine to coarse. The beginner will find it easier to cut straight with a wide or coarse blade than with a fine one, but for the delicate work and for inlaying the finer blades should be used. For ordinary purposes Nos. 1, 2 and 3 will be found suitable. Fretsaws are always variable and whenever they can be procured of good quality it is always more satisfactory and cheaper in the end to purchase a half a gross or gross at once. The blades should be sharp and true, fairly tempered, of good *blue* steel, and elastic. If too highly tempered they will snap and fly about in the most unpleasant manner. Some saws in a bunch will be cut better than others, and it is a good plan to assort them. With a little practice by passing the toothed edge over the thumb nail the difference is quickly learned. The saws belonging to each number may be sorted into three grades—the first, comprising those that are admirably sharp and therefore suitable for soft woods, walnut, mahogany, etc.; the second, those that are less sharp and adapted for ivory, bone, metal, or hard gritty woods, in the cutting of which hardly the best saw will hold a sharp tooth; and the third, those that are available for hacking purposes only.

It may be useful to mention that the saw-blades are better preserved from rust if kept in a wood or metal case.

Upon the proper *tension* of the saw-blade depends its action. For this purpose a number of frames in various styles have been invented. Some of these are exceedingly simple in construction, while others are combined with machinery and operated upon by

foot-power. A useful hand-frame is shown in Pl. XXV, Fig. 2, which explains the construction of the frame and the way in which the saw is held in it.

These frames are made of steel of flat or oval section and vary in size from 12 in. to 18 in., measuring from the saw-blade to the back of the frame. The handle is of wood. The beginner will probably find the 14 in. size to be most generally useful. In the cheaper kinds the necessary tension is obtained by drawing the arms slightly towards each other when clamping the blade. The spring of the steel will then keep the blade sufficiently taut. The better frames are fitted with tension screws which afford a means of adjusting the strain on the blade with much greater nicety.

The amateur who may wish to make a frame for himself may do so without much trouble if he will act upon the following directions. Any one, in fact, who has come to be handy in the use of carpenter's tools can make it at small cost.

First get two strips of well-seasoned straight-grained hard wood such as beech or maple, about 2 ft. long, 1 in. wide and 1 in. thick. Plane them tapering and perfectly true so that they shall be each ½ in. square at the end where the saw-blade is to be fastened. At the point where the brace is joined to the two arms, the full dimensions of the wood (1 in.) should be allowed as the greatest strain will be at this point. From the brace to the tail of the frame each arm should again taper to ½ in. Neatly round off the edges, leaving the under side of each arm flat for a couple of inches so that the brace may be closely fitted. The two arms must next be connected with the brace for which another piece of hard wood must be used. This should be 9 in. long and 1 in. square. A perfectly true flat tenon 1 in. long and ⅜ in. thick should be cut at each end and, for the sake of neatness, the edges of the brace should be slightly chamfered. About 5 in. from the tail end of each arm cut a perfectly true mortise for the tenons of the brace and fit them in tightly, securing the joint with glue and wooden or iron pins. Care must be taken that the ends of the arms lie exactly in the same plane, otherwise straight cutting will be impossible.

Now if a saw blade is fastened to this frame at the long end the leverage when the saw is in use will be too great upon the other end unless a compensating balance is supplied at the other end. The best way to achieve this balance for the saw-frame is by means of a piece of twisted cord or catgut, the ends of which

should be tied strongly together, making it into a loop just large enough to go over the ends of the frame. Prepare a stout flat piece of wood, 6 in. long, $\frac{1}{4}$ in. thick and 1 in. wide; place it between the two strands of the cord, and begin to twist it round, enough to make it just tight, and let the stick, which is technically called a *key*, protrude far enough to rest against the brace, and prevent the cord from untwisting. There will only be a slight strain upon the arms. To make a neat handle for the frame the amateur must take a piece of hard tough wood, 6 in. long and about $1\frac{1}{4}$ in. square, and at one end bore a hole, rather more than $\frac{1}{2}$ in. in diameter. Work down the remainder of the wood to make a neat handle, and pass one end of the frame through the hole, and when it fits snugly fasten the handle with a small screw, taking care that it is perpendicular to the arm of the frame to which it is attached, and hangs straight downwards. If it is desired to make a very neat job, and add to the strength of the frame, let the end of the handle through which the hole is bored be made round, and narrow metal bands or ferrules driven on, one on each side of the hole, thus rendering the wood less liable to split.

The next step will be to provide some appliance as a clamp to hold the saws. This may be made of a piece of iron wire $\frac{3}{16}$ in. in diameter and about 2 in. long. It should be cut for about five-eighths of the length with a screw-thread at one end, and have a saw-cut at the other wide enough to admit any fretsaw, and with a screw hole made transversely to the saw-cut, into which a small thumb-screw, similar to those used in mathematical instruments but rather larger and stouter, is inserted for the purpose of bringing the parts of the clamp on either side of the saw-slit closer together in a firm grip on the ends of the saw. Having procured a pair of these clamps, drill a straight hole lengthwise in the end of each arm exactly in the centre; and having fitted on each arm a brass or iron ferrule, to prevent the wood from splitting, screw in the clamps firmly, greasing the screw-thread before inserting the clamps into the holes bored to receive them so that they may be screwed in the more easily. In the fretsaw frame just described, the depth from the blade to the brace is about 18 in., giving room for cutting out a large piece of work. It must be remembered that the size of the work depends altogether upon the sweep of the frame.

There are many excellent treadle machines on the market, and the amateur would do well after he has acquired some

proficiency in cutting with the hand fretsaw to purchase one of them.

The entire framework of the ordinary treadle machine is of iron and is painted and japanned black. The arms are usually of ash and give a clearance of about 18 in. between the saw-blade and the back of the frame. They are furnished with improved hinged clamps for holding the saw. On the upper arm is fitted a dust blower which is a very great advantage, as it keeps the lines of the work free from sawdust. The machine has an iron table with an adjustable screw which permits of its being tilted for bevelling inlay work.

The balance-wheel is fitted with a rim of solid emery. On the right-hand side of the machine is generally fitted an attachment for drilling.

The amateur who may desire to proceed from the practice of ordinary fretsawing in their wood to work of a bolder and more advanced character, and may therefore require a treadle machine which while still inexpensive is of a somewhat higher grade than that already described, should acquire one of the machines of a similar kind which have been introduced in recent years for use in practical workshops. This form of fretsaw, or scroll saw as it is generally designated, is designed primarily for wood workers who desire a machine of large capacity, and which at the same time is suitable for close and accurate work. It will cut with the greatest precision up to 3 in. thick and has a clearance of 24 in. It has an adjustable tension in connexion with the upper spindle, and may be varied to suit the operator, using regularly 8-inch saw-blades, but can be adjusted to use 5 in. blades for fine work if desired. The iron tilting table is 16 in. in diameter, and can be changed to any angle for sawing inlaid work. It has an adjustable upright drilling attachment, provided with an improved drill chuck, which will hold from 0 to $\frac{5}{32}$ in. twist drill. The dust blower is large, works perfectly, and keeps the lines of the work free from sawdust. The driving wheel is 24 in. in diameter, and the driving belt being the patent $\frac{1}{2}$-in. V shape, strong power is obtained without any slipping or lost motion. The average rate of speed when sawing is about 800 strokes per minute.

Although the possession of such machines as those described considerably enlarges the field of work open to the amateur, the great majority of fretworkers will for some time at any rate confine their efforts to operations which can be performed with the hand frame and before proceeding to deal with the actual

work of fret cutting it will be desirable to enumerate the few other tools which will be found necessary as an initial equipment.

Drills.—In order to provide an entry for the saw-blade when cutting out the interior spaces of a design it is necessary to drill a small hole. This could of course be done with a fine bradawl, and some of the cheaper outfits provide only this tool for the purpose. To avoid splitting or damaging the wood it is much better, however, to use an Archimedean drill. The up-and-down movement of the bobbin on the spiral steel stock causes the point to revolve very rapidly and cuts its way through the wood. With these drills are supplied a number of points in various sizes which are held firmly in small split chucks at the end of the drill. An improved form, known as the "continuous" or "centrifugal" drill is fitted with balance weights which enable it to run continuously to the right during both the upward and downward movement of the driver or bobbin. This tool works very smoothly and rapidly.

Files.—Small rasps or files suitable for fretwork are obtainable in a number of shapes. They are used for correcting slight mistakes made in the sawing or for removing inequalities or roughness on the edges of the work.

Screwdriver.—A very small screwdriver will be required for turning the tiny brass screws occasionally used in fixing the work together. An excellent screwdriver for this purpose may be made by filing the end of a bradawl to a good square point, not too sharp, and afterwards tempering by heating it to a dull red colour in the gas flame and then plunging it into cold water.

Glasspaper and Sandpaper.—A few sheets of the medium and fine grades will be required for the purposes presently to be explained. The fretworker, as such, will have no need of the coarser grades.

Glue is used in fretwork for fixing the otherwise finished work. Full particulars for making glue have been given on p. 84, but the fretworker will find the small collapsible tubes of liquid glue to which reference has also been made (p. 86) specially suitable for this purpose.

Paste.—For affixing the designs to the wood in which the

pattern is to be cut, paste will be required. Glue and gum are unsuitable for the purpose as they are liable to stain the work. The paste should be strong, clean and free from lumps. The various preparations of this nature sold for general office use are excellent for the purpose as are also the photo-mounting adhesives now on the market. The amateur who may desire to make his own paste will find the following recipes useful.

1. *Flour paste.*—In one quart of boiling water dissolve $\frac{3}{4}$ oz. of alum and when cold add wheat or rye flour to make a mixture of the consistency of cream. Bring it to a boil, stirring all the while. To preserve the paste add a few drops of carbolic acid or oil of cloves.

2. *Starch Paste.*—Put a teaspoonful of white starch into a cup and make into a creamy mixture with cold water; then take a kettle of boiling water and pour over the starch, stirring quickly. When it assumes the condition of a stiff, translucent jelly, enough water has been added and it will be ready for use when cold. The quality of the paste will be improved by dissolving in the boiling water a small quantity of gum arabic. As in the previous case, this paste may be preserved for a considerable length of time by the addition of a few drops (8 or 10) of carbolic acid.

Miscellaneous Tools etc., for Fretworkers.—Most of the other accessories required by fretworkers will have found a place in the amateur's ordinary tool box, as they are for the greater part articles of common household use. They include a small hammer, a pair of wire-cutting pliers, a selection of very small brass screws and nails, a pair of compasses and a measuring rule. A sheet or two of carbon tracing paper will also be found useful.

Cutting Board.—For the support of the thin fretwood when using the hand frame, the worker will need a cutting board of the shape shown in Pl. XXV, Fig. 1. The amateur will find no difficulty in making this board for himself from a piece of hard wood about 18 in. long, 12 in. wide and $\frac{3}{4}$ in. thick. The cutting boards sold ordinarily are as a rule considerably smaller and lighter than this, but the larger size will prove to be an advantage by allowing the whole or a larger surface of the work to lie flat upon it. When in use the cutting board is fastened to the table or bench in the manner shown in the illustration. It will be noticed that the groove cut in the back part of the board allows the upper part of the clamp to sink below the surface out of the way of the work.

Screw Press for Glued-work.—As it is desirable that the

amateur should have as many convenient appliances as possible to help him in his work; we give below a description of another useful aid with which he may easily provide himself. This is a kind of screw press in which light glued work can be adjusted and left to dry while it may also be adapted to many other uses.

Get four strips of well-seasoned hard wood about 1½ in. wide, ¾ in. thick and 20 in. long. In each piece, about 1½ in. from the end, cut a notch 1 in. wide and ½ in. deep, into which fit cross pieces about 5 in. long, so as to form two frames. Next procure two pieces of hard wood 2 ft. long or more and 1 in. thick and exactly as wide as the space between the uprights of the frames. A screw and nut such as used in a joiner's wood clamp or hand-screw (see Pl. I) may be purchased at a small cost. Bore a hole through one of the long strips, exactly in the centre, a trifle larger than the diameter of the screw, and fasten the nut directly under it. The frames may then be slipped over the ends of the long strips between which the work will be pressed. A few square wooden blocks and a couple of square pieces of board will be found convenient to use with it. It will be readily seen that, as the various parts of which this press is composed are movable, it is equally well adapted for large or small articles which are to be glued. A 6 in. strip fastened transversely at the bottom of each standard will serve as a foot to keep it upright and steady. Of course the proportions stated can be varied to suit the taste and the requirements of the worker.

Designs.—The amateur will find no difficulty in obtaining designs or patterns for his work. There are at the present day several excellent journals devoted to the interests of the fretworker, and with these are issued each week or month full size designs of beautiful and useful articles in great variety. In connexion with these journals are also published books or sets of designs which previously appeared, and complete lists may be obtained by applying to the publishers. They include such subjects as wall brackets, cigarettes and trinket boxes, letter-racks, photograph and post-card frames, thermometer stands, time-piece cases, hand mirrors, inlay panels.

Fixing the Pattern to the Wood.—With regard to the actual work of fret cutting, the first thing to do is to paste the diagrams on to the wood. In dealing with small patterns no difficulty will be experienced in this operation, but in the case of large designs

the shrinkage and twisting of the paper when moistened with the paste is liable to cause serious trouble by distorting the lines of the drawing so that when finished the fixing joints of the various parts of the work do not coincide. To prevent this, it is safer to apply the paste to the surface of the wood instead of on the back of the design. The paste must not be too thin, and not more than is absolutely necessary should be applied. This should be done quickly by means of a flat brush or fair-sized sponge. See that the pattern is in its right position, lay it flat on the prepared surface of the wood and rub down gently but quickly before the paper has time to stretch. If any air bubbles appear, do not attempt to rub them out, but prick them with a pin and then press down. A convenient method of laying the pattern on the wood is in the first place to roll it on a round ruler and, applying one edge of the paper to the pasted surface, slowly unrolling it and rubbing it down inch by inch. When the diagram has been pasted down, the wood should be put aside until it is thoroughly dry. To prevent warping by the drying and contraction of the paper it should be placed face downwards on a table or other flat surface with a heavy weight upon the back. To absorb the moisture, a piece of thick blotting-paper should be placed over the pattern.

In deciding upon the position which the design is to occupy upon the wood it is important to remember that whenever practicable the diagram should lie lengthways with the grain of the wood. This is of course of most importance when using woods with strongly marked grain. In the case of close grained woods, such as holly or maple, the position of the diagram is more a matter of choice.

Tracing Diagrams.—When the lines of the design are few and simple or when the amateur may desire to retain a copy of it for future use, the pattern may be traced in the following manner. The design to be copied should be laid flat upon a table or wide board and covered with a piece of transparent tracing paper, both being fastened down to the board with drawing pins. Care should be taken that there are no creases in the paper. The pattern should be traced with a finely pointed pencil. If copies are required they may be obtained during the operation by placing carbon sheets beneath the design face downwards on thin sheets of white paper. The copies thus made will be found particularly useful when reversed diagrams are wanted.

Method in Fret-cutting.—In simple fretwork sawing the

method of working will present no special difficulty The piece of wood upon the surface of which the design has been pasted must be pierced in every part which is to be cut away with a hole sufficiently large to admit the saw-blade. It must then be laid on the cutting-board, if a frame-saw be used and every interior sawn out, care being taken to keep as closely as possible in the lines of the design so that very little filing and finishing may afterwards be required.

Drilling.—The work of drilling the holes in the interior spaces required for the entrance of the saw should not be undertaken until the wood upon which the design has been pasted is thoroughly dry. In order that both hands may be free to manipulate the drill, the work should be clamped down on the cutting board or table. It is well also to place underneath the work a piece of soft waste wood to prevent the drill point from breaking through too suddenly and carrying a splinter with it. The hole should in all cases be bored as near as possible to a corner or point, as these are convenient starting places. Medium sized drill rather than fine points should be used wherever space permits as the fine drills are apt to break. In order to guard as much as possible against the breakage of drills the drill stock should be held quite vertical and revolved both when the point is entering the wood and when it is being withdrawn. No pressure is required on the drill beyond its own weight. With practice and the exercise of a little care the amateur will find that accurate drilling soon becomes a simple matter.

Most of the treadle machines on the market are fitted with a drill-holder which is attached to the centre of the balance wheel. This position is not, however, very convenient. In the higher grade machines the drill works vertically and the precision necessary in fine work is much more easily obtained. When the drilling is finished and before sawing is commenced, the work should be turned over and all roughness caused by the breaking through of the drill point removed by the use of sandpaper. Otherwise, the rough edges of the holes may drag on the surface of the cutting table and hinder the free movement of the work when the frets are being sawn.

Management of the Saw-frame.—The method of holding and managing the hand saw-frame, and where to begin in cutting out a design in fretsawing, next require our attention. The hand saw-frame requires all the steadiness obtainable. The tail of the

frame should rest along the forearm, and against the shoulder if the frame be a long one, or under the shoulder if it be short (Pl. XXV, Fig. 2). This will prevent the frame from swinging round and bending the saw-blade, and causing it to cut unevenly. The saw will actually dip or describe the arc of a circle as it passes through the wood, and this dip is reduced to the minimum by making short strokes instead of long ones. Thus will plainly appear the great superiority of treadle machines, which possess this steadiness in a greater degree, being fixed at those points where the support of the workman's arm and shoulder would be otherwise necessary, leaving both hands free to guide the work.

Interior of Work to be cut First.—In cutting out the design all the interior spaces should be cut first, if possible, so that the surplus wood round the outside, may serve as long as may be for a continuous support to the frailer portions. In cutting a circular or oval frame, for example, surrounded with scroll-work, it is generally best to begin at the top of the design, boring the hole for the saw near an angle, and cutting in the direction of the line until the angle is reached at the junction of the two curves. The saw should then be run back a little more than its breadth, turned half-way round, and run close down to the angle again.

Manipulation of Saw in Cutting.—A very slight twist of the saw will cause its cutting edge to catch upon the wood fibre as a cut is commenced upon another line. Having reached the points at the top of the line, a slight sudden twist of the saw will cause its teeth to catch and follow yet another line. Backing the saw would be useless in such a case, as the angle is too acute to allow the saw-blade to turn round.

Grain of Wood.—In looking carefully at the wood when a design has been placed on it, it will be noticed that some of the lines run according to the grain of the wood. Such parts gain all the advantage of support from the grain at every point where the fibre of the wood is not severed or cut away, and wood is many times stronger on the line of its fibre than in any other direction. It will be further noticed that other lines of the work run across the grain. These being the weaker points, the adjacent support which they depend upon for most of their strength must not be removed too soon. If the weaker portions are cut away first, whenever practicable, the support will be decreased gradu-

ally and the danger of breaking will be diminished. The outer edge of the design obtains an abundant support from the waste wood of the margin which, at the same time, contributes somewhat to the strength of the interior portions, therefore this waste wood should be cut away the very last of all.

Feeding Material to Saw.—It must be remembered that the saw-blade is frail and easily snapped, and that the material should not be fed to it any faster than the teeth will cut. When the saw-blade is in action the simple pressure of the fingers is all that is required for holding the work to the table, and moving every part of the line to be cut in due succession against the cutting edge of the saw. The eye should be fixed upon the point where the saw-blade is operating, and follow the line, so that there shall be no deviation. Otherwise the vision will be distracted by the various outlines of the design.

Saw Breaking.—In the early stages of his work the amateur will doubtlessly break many saw-blades. In the greater number of cases this will be due to lack of control over the saw frame and consequent unevenness in cutting. Want of care in turning a corner or undue pressure will often cause the saw-blade to become locked in the wood and the effort to move it will then generally cause it to break. The amateur should not allow such accidents to discourage him, but should remember that the blades are extremely fragile and in any circumstances can be expected to last only a certain time. He may also feel sure that as he makes progress and acquires greater skill the life of his saw-blade will be correspondingly longer. Fortunately their cost is in any case a comparatively small item, and a broken blade can easily be replaced.

Locking is sometimes caused by a slight twist in the saw, and, for this reason, great care should be exercised in fixing the saw in the frame. It may also be due to some irregularity in the fibre of the wood, or the wood itself, as in the case of rosewood, may be naturally gummy and heavy. Generally, however, it is the result of excessive energy, a heavy pull causing the blade to stick fast in the grain. When this happens, the blade should be eased by working it gently up and down so that it does not actually cut, but merely frees itself. This method should also be adopted whenever a sharp corner is being turned.

Machine Cutting.—In treadle-saw cutting, some difficulty may

be experienced at the commencement in acquiring an easy motion and regularity of stroke. This, however, is only a matter requiring practice. In starting the machine, a slight turn should be given to the balance wheel and the movement maintained by at once applying pressure with the foot. Both hands are free to feed the work up to the saw-blade, the teeth of which are towards the worker and point downwards. In ordinary fret cutting, as distinguished from inlaying or marquetry, care should be taken to see that the tilting table is fixed in a perfectly horizontal position, otherwise the saw cut will be bevelled and the interior outlines of the spaces will appear irregular.

Removing the Design.—The first thing to be done when the whole of the design has been cut out is to remove the pattern. This may be done in various ways. Some workers use a sharp steel scraper of the kind used by cabinet makers, but great care is required in the use of such an implement on delicate fretwork. The old-fashioned way was to damp the paper and to simply peel it off as soon as the moisture had penetrated it sufficiently to soften the paste. The disadvantage of this method is that the dampness is liable to cause the wood to warp and twist. The risk of warping may, however, be minimized either by only lightly moistening the paper with a camel hair brush dipped in water or by applying a sheet of damp blotting paper to the work and keeping it there for a short time under a light pressure. The most customary way, however, is to peel off as much of the paper as is possible with the fingers or by the aid of a sharp penknife and to rub off what remains by means of sandpaper. The sandpaper used should be of medium grade and as soon as the surface of the wood appears, great care must be taken to rub only in the direction of the grain as any scratches across the grain will quite spoil the appearance of the finished work.

Finishing Fretwork.—When the paper pattern has been removed the upper surface of the work will be found to be fairly clean and the edges on that side to require very little attention. On the underside, however, the wood will present a soiled appearance and the edges will look very rough, the teeth of the saw having broken through the grain and left many ragged threads. The extent of this raggedness will depend chiefly upon the nature of the wood, the size of the saw-blade used and also the direction of the cutting in relation to that of the grain. The amateur who desires to turn out fretwork with any appearance of finish must

be prepared to devote a considerable amount of time and patient labour to the cleaning up of the wood after the mere operation of sawing has been completed. A common mistake with beginners is to imagine that the back surface, being out of sight, requires very little attention. It must be borne in mind, however, that in many articles of fretwork, both sides of the wood are visible and that even when this is not the case any ragged edges left on the back are seen from the front and must destroy the clearness of the fret. For this reason the back as well as the front of the work should be sandpapered in the first place with a sheet of medium grade and afterwards with a finer grade until a smooth and perfectly clean surface has been produced.

Holder for Sandpaper.—Sandpaper should be very carefully applied with a very light pressure, lest it wear away the surface unequally. A convenient holder for sandpaper can be made with two oblong pieces of hard wood ⅜ in. thick, and of any convenient size. In the piece of wood intended for the bottom, fix a 1½ in. screw point upwards exactly in the middle, sinking the head a little below the surface. At each end of the other piece fasten three small steel pins, with points, filed sharp, and let them protrude about 3-16ths of an inch; bore a hole in the centre the size of the screw. Place the top piece over the lower one, fitting a small wooden knob to the screw, which will serve to keep the two pieces from coming asunder while in use, and also for a handle to hold them by. A piece of sandpaper can be placed upon the bottom piece just long enough to lap over and be held by the sharp points. The bottom piece should be curved upwards slightly towards each end, so that a sharp edge may not injure any part of the work.

The use of a holder in sandpapering is very desirable, as by simply holding the sheet in the fingers it is impossible to retain the perfect flatness of the surface, and there is also the danger that the edges of the frets, instead of remaining sharply defined, will become rounded. A useful plan in dealing with delicate frets is, before commencing the rubbing, to re-insert the design in the waste wood from which it has been cut and in cases where the interior tracery is particularly fragile to also replace the small waste pieces which have been removed. In this way, the wood is practically restored to its solid form and all danger of breakage is obviated.

When both sides of the work have been given a first rubbing, attention should be given to the edges. Much of the raggedness

will have disappeared, but many loose fibres will still be discovered, especially in the interior frets. These must be removed, either by means of a small piece of glass-paper folded into a narrow slip or by using one of the small fretwork files to which reference has already been made.

Filing.—The amateur can hardly be impressed too much with the fact that filing is an operation to which resort should be had only in cases of emergency. Many expert workers will not keep a file in their outfit. Beginners, on the other hand, are often apt to fall into the habit of careless sawing with the idea that defects due to this cause can afterwards be remedied by using the file. Occasionally it happens, however, that errors are made in sawing even with the exercise of the greatest care and in such cases the file will prove of service. In cutting a circle, for instance, a tiny ridge may be left where the saw completes its round. A corner may just miss its sharpness or a curve just fall short of perfection. It may happen also that a few stubborn threads in the narrowest parts of the frets cannot be removed by the ordinary process of sandpaper. In all these cases the use of the file is quite legitimate.

All filing must be done with the greatest care, smoothly and evenly. The file, like the saw, should be kept perfectly vertical, as any departure from this position will inevitably result in rounded edges and broken outlines.

Finishing Touches.—When the edges on both sides have been perfectly cleaned up, a smooth and glossy appearance should be given to the surface by going over it thoroughly with fine glass paper. In the great majority of cases, fretwork articles look best unpolished. In some cases, however, it may be desirable to give a special finish to the work, and this may be done either by polishing or oiling the wood. Occasionally, varnish is used, but the effect is rarely satisfactory. All work which is to be oiled, polished, or varnished must first be rubbed as smooth as possible with very fine sand-paper, otherwise every little imperfection in the grain of the wood will exhibit itself to critical eyes. When the work is too delicate to bear any strain or pressure, it is best to partly polish the wood before cutting out the design, and give it a finish subsequently. The polished surface must present an even appearance, as nothing looks so unworkmanlike as blotches and streaks, and when there are any such they must be well rubbed down with an oiled cloth. Only enough oil is needed throughout

the operation to cause the rubber to glide along easily without adhering to the surface, which would produce unsightly daubs.

Polishing Wood.—First attempts at polishing wood are rarely satisfactory, but the work becomes much easier after a little practice and attentive notice of the effect. French polish will be required by the fretworker only in small quantities and will not therefore be an expensive item to purchase. If desired, however, it may be made in the following manner :—

French Polish, How to make.—Take 2 oz. picked shell lac, 1 oz. gum arabic, 1 oz. gum copal, and 1½ pints of spirits of wine. Dissolve the gums thoroughly in the spirits and strain all through a piece of fine muslin. It should be about the consistency of treacle ; if necessary it can be made thinner by the addition of some more spirits. If the gums are pure and good this will give a light-coloured polish. If a darker colour is desired, substitute 1 oz. of gum benzoin for the gum arabic and copal and use only 1 pint of spirits of wine.

French Polish, How to apply.—French polishing is done with a pad of cotton wool or with a rubber consisting of a few folds of cloth. The pad is moistened with the polish and a thin piece of soft linen rag placed over it. On the outside are placed a few drops of linseed oil and the whole is applied evenly on the surface of the work with a circular motion (see Pl. XXVI, Fig. 2). The polish dries quickly and when dried out of the rubber more must be applied as before. Porous wood will absorb a great deal of it, and, if economy is any object, a thin coat of size may be put on to fill the pores before commencing the actual polishing. Two or more applications of the polish, put on very thin, will produce a much better effect than one thick coat.

French polishing cannot be well performed with a brush, as the success of the operation depends almost entirely upon patient and continued rubbing.

Judgment necessary in Finishing Work.—The worker will find it expedient to use judgment in finishing his work and not to resort to polish, oil or varnish indiscriminately. As already indicated, some work looks well in the plain wood and any further manipulation is desirable in such cases only when some beautiful effect can be produced, exhibiting more clearly the grain or the natural colour of the material.

Raw linseed oil may be frequently used to good purpose. It

should be applied in limited quantity so that the surface may not present a greasy appearance. The pores of the wood having been filled, scarcely any further application is necessary. A merely shining appearance should in all cases be carefully avoided. If, in any circumstances, it should be desired to use varnish, spirit varnish will be found the most convenient on account of its quick-drying qualities and the hard surface which it gives.

Fixing Work together.—Many good fret-sawyers who can cut out work in excellent style find great difficulty in putting together the various parts of which it is composed. The importance of accurate and workmanlike fitting, however, can hardly be overestimated, for an elaborate and well-executed piece of work may easily be ruined in appearance by one or two clumsily made joints. The joints used in the larger work of cabinet-making and carpentry have been fully described in a previous chapter (see pp. 109–129), and the amateur who has engaged in those branches of woodwork will not only have acquired a knowledge of the various methods of fixing woodwork together, but will have learned to appreciate the need for the utmost precision and good workmanship in marking out and cutting the parts which are to be fitted together. The joints adopted in fretwork are made on the same principles as the more simple forms of joints used in cabinet-making, the only modifications being such as are made necessary by the use of slighter and more fragile material. The kinds most commonly met with in fretwork are the slot and tenon, corresponding to the mortise and tenon (see p. 122) the half-cut or halving joint (p. 126), the lap-joint (p. 127), and the wedge or dove-tail joint. In cases where the wood used is somewhat thicker than the ordinary $\frac{3}{16}$ in. fretwood, dowels (p. 94) may often be used with great advantage and in preference to the ordinary slot and tenon joint. Elaborate joints are not required, as there is rarely, if ever, any considerable strain on the work. In all modern diagrams, the joints to be used and the general method of construction are clearly shown. The amateur must, however, be careful not to treat the lines of the drawings indicating the various projections and slots as though they were merely ordinary parts of the design. He must remember that the slightest inaccuracy either in the printed pattern or in sawing will often fail to form the joint and under the best circumstances will make a bad fit. After the design has been pasted on the wood, therefore, all fixing parts shown in the diagram should be tested by drawing parallel lines in pencil from

one part of the joint to its corresponding part on the design, to make sure not only that the measurements are exact, but that the relative positions of tenons and slots are also correct. In the actual cutting of these parts it will be necessary even for the worker who may have had experience in making ordinary joints to bear in mind that a certain allowance must be made both for the additional thickness temporarily given to the wood by the paper pattern and to the reduction of the actual thickness made in the process of sand-papering. To lose sight of either of these points would inevitably result in a loosely-fitting joint. Generally speaking, it will be found advisable to cut the parts of the joint and fit them together before commencing the ornamental part of the design, as any necessary adjustment can be made much more easily while the wood is in the solid than when it has been fretted. As a rule also it will be well to cut tenons and similar parts rather full than otherwise, and, if necessary, to reduce it to an exact fit by the use of sand-paper. To strengthen the fixture glue will generally be required and occasionally nails or screws are needed.

Inlaying.—Inlaying, in the ordinary meaning of the term, as previously stated, is the art of decorating flat surfaces by cutting away the solid wood of what may be termed the ground and letting in pieces of a different colour. This form of handicraft will be dealt with in the following chapter in connexion with such allied branches of woodwork as veneering and marquetry. As, however, the fret-worker will occasionally desire to add to the beauty of his work by this method, it may be well to anticipate the detailed instructions necessary in the case of the more advanced work by giving in the present chapter a few simple directions as to the procedure adopted. Two pieces of fretwood of different colours are taken and fastened together near the edges with very fine-wire nails so as to prevent them from moving during the process of sawing. The design is then transferred to the upper piece of wood and the ornament to be inlaid is cut out in the ordinary way.

It is necessary to make the cut through both pieces of wood very slightly on the bevel, and for this purpose a bevelling attachment is added to some treadle machines, so as to keep the table on which the work is cut at a suitable angle. The inlay, in consequence, will be somewhat wedge-shaped, and a trifle larger than the hole which is cut to receive it, the sides of which will also be on the bevel. A hole, which should afterwards be

filled up with sawdust and glue, must be made with the finest drill point for the entrance of the saw which should also be very fine. When the saw has been introduced, the pattern must be steadily followed until the whole of the cut, however intricate it may be, has been made. The cutting must be done with the greatest care, as what is waste wood in the upper piece of wood from which the ornament is cut corresponds with the ground which is cut in the same operation from the lower piece. A slight blow with a wooden mallet will suffice to drive the inlay into the ground; but before doing this, the inlay should be touched at the edges with a little thin glue. The work is finished by scraping the surface with a cabinet scraper (see p. 60) to bring it exactly level, and then rubbing it over with very fine sand-paper, and polishing it if necessary. Sand-paper should, however, be used with caution, as the lighter woods are liable to be discoloured by the dust of the darker woods being rubbed into them. This is especially the case with ebony.

Overlaying.—The reverse of inlaying is overlaying, a process much more simple, yet quite as amenable to the principles of symmetry and taste. The design will stand in relief or raised from the ground, and is often capable of further embellishment by means of the carving tools.

This kind of work has been already spoken of in a previous chapter as a useful and easy means of decorating flat surfaces. A variety of figures can be cut out from thin board, which being firmly glued, bradded or pegged to some flat surface may be wrought with the carving tools, and appear to as good advantage as if carved from a solid piece. This would be far less labour than to reduce the surface from around the ornament. The good taste of the amateur, taking into account the character of the work to be thus adorned, will suggest to him many effective modes of decorating surfaces in this manner. The chief point to be remembered is that the grain of the wood from which the ornament is cut and that of the groundwork should run in the same direction. Pretty effects may be obtained by contrasts of colour—a pattern in white holly or similar wood being placed on a ground of dark walnut or ebony, or vice versa. When used in connexion with fretwork, and not intended for carving, overlays are cut from very thin wood, rarely over $\frac{1}{16}$th in. in thickness and frequently still thinner. As such boards are very fragile it is advisable, unless two or three similar patterns are being cut at the same time, to fix them to a piece of waste wood. It is also

a good plan to paste a sheet of paper to the underside of the thin wood. In fixing the overlay to the ground work it is important to see that it lies exactly in the right position. Glue must be applied very sparingly. When glued, the work should be placed under pressure and left for some hours.

Xylonite for Fretwork.—A very suitable material for overlaying has been introduced in recent years in the form of sheets or panels of thin xylonite. These sheets are of a uniform thickness of $\frac{1}{25}$ in., and are especially suitable for delicate overlaying or for miniature fretwork. They are made in a wide range of colours such as cream, white, red, blue, green and vulcanite black and include excellent imitations of ivory, mother-of-pearl and tortoiseshell. Xylonite may also be obtained in panels $\frac{1}{8}$ in. thick, suitable for solid fret-cutting. Xylonite should not be cut alone but should be placed between two thin boards. It is easily cut. Oil should never be used to lubricate the saw. It must be remembered that xylonite is a very inflammable material and must therefore not be placed near a fire or light.

Another substance which has become popular with fretworkers for the purpose of overlays is aluminium. This may also be obtained in prepared sheets $\frac{1}{16}$ in. in thickness with a satin-finish surface. This metal, being very soft, is sawn without any difficulty, although in working in it it is desirable to use the special metal-cutting saw-blades with close teeth which are made for the purpose.

Miniature Fretwork.—Visitors to exhibitions of modern fretwork are impressed with the extreme delicacy and beauty of many of the specimens of miniature work to which fretworkers have recently turned their attention. These miniatures are generally cut in xylonite or very thin pieces of close-grained wood. In exquisite detail and beautiful finish, they compare favourably with the filigree work of the silversmith, and the artistic blending of colours often gives the effect of enamel work.

In conclusion, the attention of the amateur may be called to the large variety of fittings and ornaments which may be obtained from the various firms specializing in the supply of fretwork material. These include well-made brass hinges in sizes suitable for small articles, locks, drawer handles, and corner pieces, together with emblems and medallions beautifully modelled in relief. Small bevelled edge mirrors, scent bottles,

and cut-glass ink-bottles are also made in forms and sizes suitable for use in connexion with the making of useful articles in fretwork. For the softening of outlines, the miniature mouldings and beadings also obtainable may be used with excellent effect. Fully illustrated lists of these accessories may be obtained on application to any of the firms advertising such specialities in the various periodicals devoted to the interests of the amateur woodworker.

CHAPTER IV

VENEERING, INLAYING, MARQUETRY, AND ALLIED HANDICRAFTS

THE purpose and the merits of veneering having already been explained, we may in the present chapter at once proceed to consider the practical methods by which the actual process is carried out.

Veneers.—These are of two kinds and are known as knife-cut and saw-cut. The former are the thinner, the average thickness being about 36 to the inch. Knife-cut veneers are much cheaper than the saw-cut variety and, with the exception of what are known as burr veneers, are generally plain in figure. Most of the commoner woods, such as ash, oak, mahogany and walnut, are obtainable in the knife-cut form. These are used in the construction of the cheaper kinds of furniture, but for better-class work and where durability is desired they are not to be recommended. The choicer woods such as satinwood, rosewood, and figured mahogany are rarely to be found as knife-cut veneers. Saw-cut veneers are cut about twelve or fourteen to the inch. They are usually sold by the leaf or sheet, the prices being calculated on the rate per superficial foot, or, in the cheaper varieties, per 100 superficial feet. In the case, however, of certain hard woods of small and irregular growth, veneers are sold by weight. Burrs are sold at special prices, which vary according to their size and the beauty of the marking.

The operation of laying a veneer, if carried out methodically, presents no special difficulties. The amateur artisan should be careful to get well-seasoned veneers, and to use the strongest and best glue: upon these his success mainly depend. Some woods are of course dealt with more easily than are others;

bird's eye maple is laid with least trouble and difficulty; rose-wood is the most troublesome to lay.

Veneering Hammer.—When veneers are laid upon flat surfaces the operation is simple enough, and may be effected by the operation to be described presently; but when they are laid upon curved surfaces, an instrument the shape of the curve, and called a "caul," is generally used. The amateur artisan, however, will find that the veneering hammer, of which an illustration is given in Pl. XXVI, Fig. 3, will enable him to lay his veneer quite as well as, and sometimes better than, can be done with a caul.

The hammer, which may easily be made at home, consists of a piece of hard wood, such as beech or ash, about 6 in. in length, 4 in. in width, and 1 in. in thickness mortised firmly to a strong handle about 12 in. in length. Into the lower edge of the head is fixed a stout piece of steel, of which the edges have been rounded and made perfectly smooth so that it may glide over and not cut or scratch the veneer. For the same reason the corners also should be slightly rounded. It should be noted that the veneering hammer is used as a squeegee or scraper and not as an ordinary hammer.

Preparing the Ground.—Supposing the hammer is to be used, the ground, that is to say, the surface upon which the veneer is to be laid, should be planed perfectly true and roughened by going over either in the direction of the grain or crosswise with a toothing plane shown in Plate III, Fig. 4. This tool is about the size of a smoothing plane. The iron, which is fixed in an almost upright position, is grooved so as to give the cutting edge a row of teeth something like those of a fine saw. This plane can also be used for other purposes and when fitted with a scraper blade will do excellent work in clearing a surface of old paint or glue. A very important point is to see that the veneer is laid upon the heart side of the wood. The tendency of the wood forming the ground is always to go hollow away from the heart. so that if the veneer is laid on the heart side the shrinkage of the veneer will tend to equalize the pull and the ground will remain flat. In addition to taking this precaution many workers slightly round the back by wiping it over with a damp rag, from time to time shortly before veneering. Any knots which may happen to be in the ground should be cut out and the hole filled in either with a piece of wood or with a mixture of plaster

of Paris and glue. The surface should then be well sized and allowed to become thoroughly dry.

Preparing the Veneer.—The principal point with regard to the veneer itself is to make sure that it is quite dry before the operation of laying is commenced. The leaf should also be examined for splits, holes or other imperfections and these should receive attention. In the case of mere splits, the edges should be brought close together and held in position by gluing a strip of thin strong paper over the defect. Burr veneers, however, have generally a large number of cracks and holes of irregular shape which cannot be "stopped" in the ordinary way, but which must be filled in by letting in pieces of the same kind of wood. This mending must be done in such a manner that, when the surface is finished, it will not be noticeable. In order to secure a perfect fit, the piece to be let in should be placed over the hole to be filled and the two veneers sawn through together with a fine fret-saw. The piece cut out should not be of any geometric form, but irregular in shape, the saw-cut being made to correspond as far as possible with the markings of the wood. The pieces thus cut out should be fitted into the respective holes and pieces of paper glued over to hold them. Veneers which are at all twisted should be flattened by damping them till they are quite pliable and then laying them between well heated boards and keeping them for some time under pressure. In the case of rosewood, the veneer should not be damped, but merely warmed until the natural oil or resin which it contains begins to exude. Care should be taken that all veneers which have been damped are well dried before being laid.

The veneer required for any piece of work should be cut slightly larger than the groundwork upon which it is to be laid, the rough edges being cleaned off afterwards. For thin veneers with straight grain, the best cutting tool is a broad, sharp chisel; in other cases a fine dove-tail saw should be used.

Laying Veneer: (*a*) *Knife-cut Veneers.*—In laying veneer with the hammer it is particularly important that everything necessary should be ready at hand before the actual operation is commenced. The glue should be boiling hot and of such a consistency that, without being too thin, it can be spread easily on the surface of the wood like varnish. If the veneer to be used is thin and of a light colour the glue is apt to be forced through and cause discoloration. In such cases, either colourless glue should be used

or ordinary glue may be lightened in colour by the addition of a small quantity of powdered chalk. There should also be at hand a heated flat iron, a supply of very hot, clean water and a sponge.

When everything is ready, the glue should be spread quickly and evenly over the whole surface of the ground, and the veneer at once laid on and lightly rubbed down with the hands. The surface should then be damped, though not flooded, with the sponge dipped in hot water. Taking the handle of the hammer in the right hand and pressing firmly on the head with the left, the worker should proceed by passing the iron edge rapidly over the veneer in all directions beginning at the centre and working towards the edges to expel the air and superfluous glue from between the surfaces. When, by these preliminary strokes, some of the glue has been forced out, the hammer should be passed over the whole surface more slowly and in a systematic manner, and working with a zig-zag or wriggling motion from the centre to the edges. In order that the hammer may work freely, the surface of the work should be kept fairly damp and at times a little soap may be applied. Instead of using soap, some workers mix a little glue with the hot water. If the glue should become set before the veneer is properly laid or if blisters should appear in places, the surface should again be damped and pressed out with the hot flat-iron, the face of which should be first rubbed with soap. By this means, the glue will be re-melted and no time should then be lost in going over the surface again with the hammer. In order to discover any blisters which may not be clearly visible, the veneer may be tapped lightly with the handle of the hammer. They will then be detected by the hollow sound which will be given from the places in which they occur. Blisters may be removed while the glue is hot without much difficulty, but if left till the glue is set they are often troublesome to deal with. They may often be laid by placing a wet cloth on the spot and upon this pressing a hot iron. In order that the imprisoned air may escape, a hole should be pricked in the veneer or a cut made with a sharp chisel in the direction of the grain. In some cases, however, it will be found necessary to cut out a piece of the veneer with a knife and to re-lay it. In this operation, the method adopted should be that already described in connexion with the mending of burr veneers.

(b) *Saw-cut Veneers.*—For laying the thicker or saw-cut veneers considerable pressure will be required. This is obtained

by placing the work in a press, such as that described on p. 177, or by using a number of the wooden hand-screws or clamps to which reference is made on p. 69.

Cauls.—In addition to such appliances as presses or clamps the amateur must provide himself with what are termed "cauls." Cauls are pieces of wood or metal, made to fit exactly to the surface to be veneered, by means of which the veneer and the ground, when placed under pressure, are held firmly in close contact until the glue is set. Wooden cauls should be made of well-seasoned boards of pine or mahogany, about 1 in. thick, perfectly flat and true and of such a size that they will cover the veneer.

In practice it is found to be advantageous to make the caul of wood thin enough to bend slightly under great pressure, and to cut it in such a way that, while it touches the surface to be veneered in the middle, it does not fit so closely along the sides or edges, so that in fact when the surfaces were brought together they would move slightly on and along the line of contact and each of the edges would open according as one or the other in each surface were brought closely together, the opening being sufficient to admit a thin piece of cardboard.

Metal cauls are made of zinc, generally about $\frac{1}{8}$ in. thick. In workshops they are now generally displacing the wooden cauls. The principal advantages claimed for them are that they are more durable and that they do not adhere to any glue which may have escaped. On the other hand, there is the risk that, especially when used by the novice, they may be made too hot for the purposes of the work. On the whole, there is little to be gained from their use, and the amateur who has not a great deal of veneering to do will find that the wooden cauls will meet all his requirements.

Saw-cut veneers should always be toothed on the under-surface with a fine plane. This will roughen the surface and at the same time remove the saw-cuts which would otherwise be noticeable through the veneer.

When the article has been prepared and the veneer is ready, all that is necessary is to brush over the surface with glue, lay on the veneer, and then the caul, which should be warmed before it is used. In order to prevent any shifting a veneer pin should be inserted at each corner. Pressure must now be applied to lock the caul, the veneer and the wood to which it is glued closely together. Before using the cauls they

should be rubbed over with a piece of the best yellow soap, or a sheet of paper should be laid between the caul and the veneer. This will prevent them from adhering should any of the glue find its way through a hole in the veneer. By reason of the caul touching only in the middle of the work, it will be found that when the caul and the wood are brought forcibly together along the edges by means of hand-screws, the pressure will have commenced along the centre and proceeded from this line outwards on each side as the edges were brought together, forcing before it any superfluous glue, which will ooze out along the edges. The use of a caul the surface of which is in any degree hollow would tend to force the melted glue towards the centre and this must be carefully avoided.

The work should not be removed from the press until the cauls are cold and should then be put aside to allow the glue to harden and to become perfectly dry before the work of cleaning up is commenced. Three or four days may to the eager amateur appear to be an excessive time to allow for drying, but it would be extremely unsafe to work on the veneer until after the lapse of this period and, in some cases, the better plan would be to wait at least a week. It should be borne in mind that any blisters caused by the softening of the glue in the process of scraping and smoothing the surface cannot be removed and may easily ruin the work upon which so much care has previously been spent.

Cleaning up the Veneer.—Thin veneers are cleaned off with the cabinet-makers scraper (see p. 60) and finished with fine glass-paper. When size has been used in the process of laying it, the work of scraping may be made much easier by rubbing over the surface with a little soap. Saw-cut veneers may in some cases be cleaned off with the smoothing plane, which must be very finely set so as to take off as little of the surface as possible. Generally, however, the safer plan will be to go over the surface with the toothing plane so as to remove the saw-marks and level it, and then to finish off with fine glass-paper.

Veneering Edges of Boards.—When, as in the case of veneering the top of a sideboard, it is necessary to cover the edges as well as the upper surface of the ground, the edges should be dealt with in the first place. When these are dry and have been cleaned off, the upper surface should be veneered. The grain of the veneer covering the edges should run in the same direction as that of the ground wood. A common practice at one time was to

cross-band all the edges—that is, to lay the veneer with the grain perpendicular instead of horizontal and even now the method is often adopted in cheap cabinet work. The effect, however, is to give an unnatural and weak appearance to the work, and the arrangement should, whenever possible, be avoided.

In laying veneer on the end grain of a piece of wood the pores of the wood should be first closed with glue well rubbed in and allowed to dry. This should afterwards be toothed over in the same way as the upper surface.

Veneering Curved or Round Work.—In all curved or rounded work the surface of the caul used must conform closely to that of the surface to be veneered, of which it should, in fact, be the exact converse. In workshops where a large number of articles of the same shape, such as piano-falls or drawer-fronts, are turned out, cauls either of wood or zinc are made for the particular purpose. In ordinary circumstances, however, such special cauls will not be required by the amateur. A very effective method of dealing with curved surfaces, especially in the case of concave work, is to use bags of sand of sizes suitable for the work in hand. The bags are made of stout ticking or calico. The sand, which must be fine, should be heated as much as possible in the oven on a metal plate and then poured into the bag. The bag of sand when applied to the veneered surface will adapt itself to any curve. The pressure necessary to force the sand caul into close contact with the veneer may be obtained by placing on it strips of flat board and using clamps in the usual way.

For cylindrical work and forms to which the sand caul cannot easily be applied, a good plan is, after the veneer has been glued and laid, to bind it round tightly with chair webbing, wide tape or strips of strong calico. If, after the end has been made fast, the webbing is damped, it will shrink and, being drawn tight, will serve the purpose of a caul.

In applying veneer to sharp curves in the groundwork, there is always the danger of splitting unless precautions are taken. In such cases the top side should be backed by gluing on a piece of strong paper or thin calico.

Repair of Veneered Furniture.—In replacing damaged portions of the veneer on old furniture, every care should be taken to make the repair unobtrusive. The piece to be taken out should be first marked out in the manner described when dealing with defective burr veneers (p. 193). It should then be cut through

along the marking with a sharp chisel and removed by applying a well heated flat iron until the glue has been softened, and the veneer lifted by means of a knife blade. All traces of the old glue should be sponged out with hot water. The new piece of veneer should be carefully matched, the direction of the grain and the marking corresponding as closely as possible to that of the old surface which is to surround it. When the groundwood is quite dry, it should be brushed over with thin glue as should also the underside of the veneer. The piece of veneer should then be placed in position, a piece of paper laid over it and a hot caul applied and clamped down in the usual way.

Small defects in old veneers can often be dealt with by using a filling composed of equal parts of beeswax and resin melted together and coloured to match the wood. This mixture must be pressed into the hole or other defect in the surface, levelled off and allowed to set. When quite hard, it should be smoothed down with fine glass-paper.

Inlaying.—In dealing with the subject of fretwork it was shown how the beauty of the work might sometimes be increased by letting into the solid ground pieces of wood of a different colour and of an ornamental form. In the wider meaning of the term, however, inlaying is quite independent of fretwork and, as already explained, consists in cutting into the surface of solid wood and replacing the material removed with other decorative substances such as more ornamental wood, metal, pearl or ivory arranged according to some pattern or design. It would be altogether beyond the scope of the present work to enter into any detailed description of the methods adopted by the professional craftsman in producing the beautiful examples of inlaying often seen on high-class furniture, and we therefore propose to restrict our considerations to the ordinary processes in which the amateur who merely desires to possess himself of further means of beautifying his own work is likely to engage.

Tools.—The principal tools required for the inlaying of simple geometric forms are a fine dove-tail saw, chisels, a mallet, a hammer, a sharp knife and a steel scriber of the kind used by engineers and metal workers.

Ornamental Woods and other Materials for Inlaying.—Most of the ornamental woods used in veneer work and of which a description has been given in a previous chapter (pp. 163-172) may be utilized for the purposes of inlaying. Ebony, holly, rosewood,

walnut and amboyna will be found especially useful. In the selection of various woods to secure harmonious blendings and pleasing contrasts and also in the arrangement of the grain the amateur will find full scope for such artistic feeling as he may possess. Stained veneers of every colour can be obtained and striking effects produced with them, but, generally speaking, the natural woods with their infinite variety of colouring and marking, are to be preferred to the artificially tinted material. Amongst the most effective combinations are satinwood and walnut, rosewood and oak, tulip and kingwood with sycamore and ebony and holly with oak.

Other materials used in inlaying are metals—such as silver, brass, copper, and pewter—ivory, mother-of-pearl, and tortoiseshell, all of which can be obtained commercially in a form suitable for inlaying. For certain kinds of inlaying coloured wax and gesso, a mixture of whiting and glue, have special merits.

Prepared Inlays.—Most of the firms dealing in veneers stock a large selection of inlays prepared for use in cabinet-making. The prices are extremely low, and the amateur who may desire to avail himself of this ready means of decorating his work cannot do better than obtain one of the illustrated catalogues issued by these firms. In these lists are illustrated many of the cross-bandings suitable for the edge of the top of a cabinet or sideboard, and the mosaic bandings used for the decoration of work-boxes, writing desks and similar articles. Single strings for lining are sold by the dozen, and may be obtained in black, white or coloured woods in widths varying from $\frac{1}{32}$ in. to $\frac{1}{8}$ in. in lengths of 3 ft.; the mosaic bandings are sold similarly in lengths.

No difficulty will be experienced by the amateur in letting in these prepared inlays. A very efficient tool is now sold for the purpose, and is known as a lining or stringing router This tool is furnished with six interchangeable cutters, varying in width from $\frac{1}{16}$ in. to $\frac{3}{8}$ in., which may be adjusted to the required depth of the groove. It has a movable fence which may be reversed to suit different curves in the wood. When using the broad irons, it is desirable in the first place to cut the outside lines of the band before using the router. In the case of the single strings, the simple plan adopted is to use a marking gauge in which the steel point has been replaced by a nail filed down to the required width and given a sharp cutting edge like that of a

chisel. This should project from the stock of the gauge to a depth slightly less than the thickness of the string. The gauge is used in the ordinary way and the channel or groove for the string is made entirely by means of the cutting point, which acts in the manner of a router. The string is placed along the groove and pressed down by running over it with the back of the hammer head, a little glue being used to hold it. The channel for the wider mosaic bands is cut in a somewhat similar manner, but the gauge is furnished in place of the nail with two sharp cutters set to the required width like the marking points of a mortise gauge. These cutters mark the edge of the groove. The ground inside the lines is cut away with the fenced lining and stringing router or a blade of thin steel may be fixed upright in the stock of an ordinary marking gauge and used for the purpose, A simple method of fixing the blade is to make a fine saw-cut in the end of the stock and clamp it in this by inserting a small screw on each side (see Pl. B, Fig. 7). In order to ensure a tight fit the grooves should be a shade under rather than over the width of the bandings strings. In neither case should the work be cleaned off until the glue has thoroughly set, as otherwise the shrinking of the glue will cause the inlay to sink below the surface of the work.

Generally, these mosaic bandings are sold at such low prices that the amateur will not desire to make them for himself, but circumstances may arise in which a short length is required to match the pattern in a piece of old work under repair. In such cases a little study of the inlay will show the simple manner in which such work is built up. The centre portion of the bandings consists of an alternating series of strips of dark veneer wood about $\frac{1}{16}$ in. in thickness and strings of light-coloured wood of the same thickness glued together. To each side of this layer is glued first a veneer of light-coloured wood and then one of darker wood. The separate parts are all cut across the grain. The bandings are obtained by taking off slices from the end of these layers. The more complicated patterns are produced in a similar manner, merely requiring a more detailed arrangement of strings and strips. The cross-grained strings may easily be cut from the end of a piece of veneer by means of a fine dove-tail saw and a straight edge. It will be noticed that in some patterns the strips are cut, not directly across the grain, but in an oblique direction.

When dealing with the larger prepared inlays the outline is marked, while the pattern is held firmly in the position it is to

occupy, by running a sharp-pointed steel scriber round the edge. When glued into place, it should be pressed down with a hot caul in the same way as if it were a piece of ordinary veneer. The cleaning off should be done with a steel scraper. Several days should be allowed for the glue to dry and shrink to the full extent.

Cutting out and Building up Patterns.—The wood used will in most cases be of ordinary veneer thickness, and specially selected for the purpose of the particular design. The separate parts of which each pattern is built up are either marked out directly on the wood by means of carbon paper or traced on thin paper which is afterwards stuck on the veneer. The outlines must be cut with a very fine fretsaw such as used by marquetry cutters. When a number of pieces of similar shape are required several pieces of veneer are glued together with a piece of soft paper between each layer and cut at the same time. These pieces can afterwards be separated by means of a thin knife blade. The pattern may be built up by gluing the parts face downwards in their proper position to a sheet of paper. Where, as in the case of a border of floral design, there are small pieces not connected with each other, these may be inlaid separately as they are cut. The underside of the veneers should be roughened and the ground scratched or pricked in order to form keys for the glue.

Pearl, ivory, tortoiseshell and metal may be cut with the fretsaw as easily as wood. These materials should, however, always be secured between two pieces of veneer during the operation of cutting, the outlines to be cut being marked on the upper piece of veneer. To clean off these substances a flat file should be used in the first place and a finish given with fine pumice powder and glass-paper. Inlaying, when metal or other materials, such as those mentioned above, are used, is commonly known as "Buhl" work. It derives its name from the fact that it was introduced by André Boule, a French wood-carver of the time of Louis XIV.

Inlaying with Coloured Wax.—For this purpose ordinary beeswax is used. Any colour may be obtained by melting the wax and mixing with it the ordinary colour powders obtainable at oil-shops. On account of the softness of the material this process is suitable only for linework and for filling very small spaces. The lines of the design are incised in the wood with a V-shaped carving

tool and the melted wax run into the lines from a small tin saucepan fitted with a suitable lip. The wax soon sets quite hard and the cleaning off may then be done with a scraper in the ordinary way. Glass-paper must not be used. If desired, the design may afterwards be protected by giving the whole surface a coat of polish, although this is not really necessary.

Marquetry.—From the particulars already given of the various branches of ornamental woodwork it will be noticed that the chief difference between ordinary inlaying and marquetry is that while in the former case the inlaying is let into a solid ground, in marquetry, the whole of the pattern, including the groundwork, is composed of quite thin wood or other material which, when completed, is treated precisely as a piece of ordinary veneer. A further difference is that, while inlaying is a purely flat decoration, no endeavour being made to produce effects of perspective or relief, in marquetry an attempt is often made to obtain such effects by shading the work or even by the use of actual colour.

The extreme nicety required in performing the operation of marquetry-cutting will deter many amateurs from attempting it, but the work is after all merely a development of the more simple form of inlaying with which the fretworker often decorates his work and with regard to which instructions have already been given (see p. 188). In the modern practice of marquetry-cutting, as many as four, or even six, thicknesses of veneer are put together, and so cut. The pattern is traced or pricked on the outer piece, which is usually the ground. The various layers are held together by gluing pieces of paper between them so that when the cutting is done they may easily be separated. The pattern is thus cut through all the veneers at the same time and as a result several repetitions of the design are produced with variations in ground and pattern. After the separation of the layers, the required pieces are selected and arranged in places, being retained in position by a piece of paper glued over the whole of the face side. Any tiny holes made for the entry of the saw-blade or any interstices which may be noticeable may be filled by rubbing in filings of the actual material, but every care should be taken to secure a good fit and avoid as far as possible the necessity for any "touching-up." In professional work, the actual cutting is done with a fretsaw fixed in an ordinary frame, the work being supported by an appliance known as a "donkey." The "donkey" consists of a seat to which is

fixed an upright vice or pair of jaws in which the veneer is held while being sawn. As the tool is little known and difficult to obtain, it will be useful to give sizes to guide those who wish to make one. The seat, or bench, is 3 ft. 10 in. long, by 1 ft. 2 in. wide at the round end, 11 in. at the narrow or square end, and hollowed out to 6 in. at the narrowest part. It is made from 1½ in. pine, supported at the two ends by legs of the same substance mortised and tenoned to it. Between these is a stretcher fixed by the same kind of joints, 3 in. above the floor. Fitted into the top, about 12 in. from the front, are the jaws. These are made of oak and firmly wedged in from below the seat. Between the jaws, at the bottom, is a piece of wood, 1¼ in. thick, to keep them apart; and just above this the back piece is hollowed, to allow it to be bent forward when pressed against, and so grip anything between the upper ends. The pressure is communicated through another piece of wood hinged to the seat and slanting upwards to the rear jaw. This slanting piece is connected by a wire with the lever hinged to the stretcher, and is made to bear against the upright on the lever being depressed with the foot.

In using the "donkey" the veneer is held between the jaws, which grip it so closely that the risk of breakage of the finest strips is reduced to a minimum. The saw is held horizontally, allowing the blade to work, when necessary, close to the jaws. The pressure of the foot being relaxed from time to time as the cutting proceeds, the jaws open to allow the wood to be moved towards the saw in accordance with the design. In this way the wood is almost continually moved, the foot working in correspondence with the hand. In the "donkey" just described the worker sits on the side. In another form, which is commonly used, the sawyer sits across it, but it is doubtful whether there is any advantage in this arrangement. Although such an appliance as described above will be found of great convenience when any large amount of cutting is done, it is by no means essential to the amateur who may wish merely to try his hand at such work. For such a purpose the ordinary fret-cutter's outfit will be found to be all that is necessary, the work being held during the process of cutting either on the usual fret-cutting table or in a parallel hand-screw fixed in the bench vice.

The effect of shading often seen in marquetry is produced very easily by placing the wood to the required depth in very hot sand and allowing it to remain as long as may be neces-

sary to scorch it sufficiently. The shading must, of course, be done before the separate pieces are fitted together.

Marquetry patterns should be laid by means of a caul exactly in the manner described in the case of ordinary veneers and the process of cleaning off and finishing is the same as that adopted with other kinds of inlaying.

Intarsia (see p. 150).—The processes followed in this form of marquetry are in all respects similar to those already described and with regard to them nothing further need therefore be said. In the choice of woods, suitable to a particular design and in the arrangement of the grain necessary to produce the desired pictorial effects the amateur will find ample scope for the display of his artistic abilities. A good idea of what may be done in this kind of work may best be obtained by a visit to a museum and, for actual work, suitable designs in great variety may be found in the various technical journals dealing with this and similar handicrafts. Early attempts should be restricted to very simple forms and the number of woods used in any particular piece of work should be as limited as possible. An easy example for the beginner will be a small landscape, with a tree or rock in the foreground and a bit of sea beyond. For the sky, white maple may be used, the grain being horizontal, for the water, the stained grey sycamore, known as silver-grey, or a light piece of satinwood will produce a good effect. For the foreground, dark burr walnut or a blend of satin walnut and dark walnut will be suitable. For tree trunks in the foreground, oak, with the grain upright, should be used; the effect may be heightened by using pieces of oak with different grain and figure according to the position of the trees. Snow effects may be produced with white holly or sycamore and sharply defined lines obtained by using such dark woods as rosewood or ebony. These suggestions may be helpful to the amateur in the early stages of his work, but he will find, however, that one of his chief interests in intarsia lies in the discovery of new effects which, by using his own discrimination in the selection and arrangement of material, he may produce in endless variety.

Parquetry.—Reference to the use of geometric forms in inlaying small articles has been made in connexion with the construction and use of mosaic bands, and as it is improbable that the amateur will extend the use of such forms to the decoration of large

surfaces it will be unnecessary to give any further description of this class of work.

The consideration also of parquetry as a kind of mosaic of wood used for ornamental flooring lies quite outside the scope of the present volume. As a matter of general interest to the woodworker it may be said, however, that in the production of the remarkable effects in this kind of flooring, advantage is taken of the contrasts afforded by the difference in colour and grain of such woods as oak, walnut, ash, teak and greenheart. The patterns adopted are entirely geometrical and angular, chiefly squares and triangles, and may be formed either with solid blocks of wood grooved and tongued together, or of veneer, about a quarter of an inch in thickness laid over ordinary flooring boards. These blocks may be obtained ready for laying from any of the large firms specializing in such work whose advertisements appear in the various journals devoted to the interests of the building and-timber trades.

CHAPTER V

WOOD CARVING

ALTHOUGH so beautiful in its results, carving is a slow process. The rules are few, and the art difficult to explain, practice in it being of far more importance than precept. But, however true this is, some plain and general directions may be given for the guidance of the amateur carver, leaving it to his judgment and intelligence to make such variations and applications as may be found necessary.

Choice of Woods.—On account of its toughness and durability, the most suitable wood for general use in wood-carving is oak. Other useful woods for the purpose are walnut, mahogany and teak. For fine work sycamore, apple, pear and woods of similar grain are frequently used. For bold work, and especially for such carving as the beginner is likely to undertake, yellow pine has many advantages, the chief being softness and evenness of grain. Whatever kind of wood may be used, uniformity of grain, together with absence of knots, is essential, if good results are to be obtained.

Tools used in Wood-carving.—The tools used in carving are the chisel, the gouge, the skew-chisel, and the parting-tool, but

each of these has its variations, the peculiar shape of which adapts it for use in confined spaces, where the relief of the carving being in the way, the shanks of the other tools could not be carried back far enough to make a clean cut.

The **Chisel,** generally described in toolmakers' catalogues as a *firmer* and shown in Pl. XXVII, Fig. 1, is made in various widths from $\frac{1}{32}$ in. to $1\frac{1}{4}$ in. It has a straight edge, and is used for plain surfaces removing superfluous wood and grounding. It is the most necessary tool of the set. For cutting hollows too deep for the usual form of chisels bent chisels or grounding tools are used.

The **Gouge** used in wood-carving has a curved edge of various sweeps, according to the depth to be cut. It ranges from almost flat to the exact half circle, in about eight different sweeps. The variations of the gouges are the spoon bit or entering gouge, the back-bent entering gouge, the fluting gouge and the double bent fluting gouge. These take their names from peculiarities of construction or from the particular purpose they are made to serve.

The **Skew-chisel,** although generally considered as a distinct tool, is a modification of the chisel, the edge being ground back from either corner, the tool being either right or left hand. It is useful for working out the inside corners or angles where the edge of the ordinary square chisel would be too wide. Its variation is the skew spoon-bit or entering chisel.

The **Parting Tool** is a kind of gouge or grooving tool with an angular shaped edge. Its cut is V-shaped and it is absolutely essential for cutting angular grooves. The parting tool is straight or bent and, like the other carving tools mentioned, it has its spoon-bit variations.

Spade Tools.—For advanced work special gouges with very slight curvature, called on account of their shape "spades" or "fish tails," are required. They are used for finishing off fine work.

The **Veining Tool** is a parting tool on a small scale, being narrow, and is used to engrave the veins of leaves and for similar work.

The tools described above are usually supplied by the toolmakers unhandled and ground to a sharp edge, but not "set."

This is due in the first place to the fact that it is difficult to keep tools with specially finished edges for an indefinite time and also because many workers prefer to set their own carving tools. At a small additional cost, however, the tools may be obtained properly fitted with handles of any shape preferred and set and buffed ready for immediate use. Carving tools, because of their shape and the necessity of having them well tempered, are more expensive than similar tools of their class, but it is better that the amateur should buy good tools and but a few of them, and give a good price for them, than to provide himself with a great many at a cheap rate. Such tools may be had at all prices, but it is more economical in this case, as in many others, to buy the best, as these will prove the cheapest in the end. The amateur who is in doubt as to the number and kind of tools he should select in order to make a start, will do well to purchase one of the small sets made up and offered by the various firms for this purpose. Other tools for more advanced work may then be acquired as they are needed.

In addition to the tools above described the worker will from the outset require one or two simple appliances.

Fastening down Work.—As both hands are used in the actual operation of carving it is necessary to secure the work firmly to the table or bench.

To accomplish this clamps of various sorts are used where the shape of the work will admit. A simple method of fastening down work to the surface of a table or cutting-board is by means of a flat bar of wood, having holes at each end through which round-headed screw bolts are passed. These bolts go through holes in the table corresponding with holes in the bar, and the bar is brought down tightly on the wood so as to hold it securely by screwing up the nuts underneath. Another method is to use the hard-screws as shown in Pl. XXVII.

The Carver's Screw is an iron screw from 6 in. to 10 in. in length with a long sharp point, also threaded, at one end. The other end is made square. It is fitted with a large winged nut. The point is screwed firmly into the under side of the work, the wing nut being used as a lever. The shaft is then passed through a hole in the bench and the nut is screwed on and tightened up. If the work is thin so that it affords insufficient hold for the point of the screw, it may be fastened down with ordinary screws to a piece of stout waste wood. The carver's screw will be found very convenient in use, as

by slightly slackening the nut, the work may be turned round to any desired position. A further advantage is that no part of the work is covered as when other forms of holdfasts are used.

Mallet.—The form of mallet generally used by the carver is shown in Pl. XXVII, Fig. 1.

Knives.—For chip carving and similar work knives of special patterns will be required.

Punches.—For imparting to the ground of a panel or other piece of work a roughened or "matt" surface so as to throw the pattern into better relief, stamps or punches are needed The end of the punch is generally roughened or indented something after the manner of the surface of a coarse file, but various ornamental patterns are also used.

Rifflers are merely a variation of the ordinary rasp or file, each end being curved and ridged. The ends, being formed in this way, can be introduced into corners and crevices where the ordinary file could not be used.

Sharpening Carving Tools.—It is extremely important that the tools used by the carver should be always kept in perfect condition. The edges should on no account be allowed to grow dull or "scratchy," but should be kept in razor-like order by the use, whenever necessary, of the oil-stone or buffing strap. The directions given for sharpening joiners' tools (see Part I, Ch. IV) will apply equally to the carving tools, but for certain tools oil-stone slips of special shapes will be required. In particular, for use on the V-shaped tools, slips, with triangular sections corresponding closely to those of the tools, are necessary in order to wear down each side in exact uniformity with the other.

General Directions as to Use of Cutting Tools.—The tool, when in use, should be guided by the left hand while it is pressed forward by the palm of the right hand, which should rest on the top of the tool handle. Thus steadiness will be given to the tool, and if the steel is good and the edge sharp, the cut will exhibit a corresponding smoothness.

Direction of Cutting.—With regard to the *direction of the cutting*, or, in other words, the direction given to the tool, this should be invariably *down* and not *up*—away from and not towards the higher surfaces. This will be governed by the grain

Plate XII.--MARKING

(1) Marking with line and [illegible] and [illegible] Using mortise gauge for marking mortise and tenon (4) Drawing a line with rule and pencil

Plate XIV—SHARPENING TOOLS

(1) Sharpening centre bit (2) Filing teeth of saw, (3) Setting teeth of saw, (4) Setting gouge on oil stone, (5 and 6) Setting plane iron

of the wood. The material, as it has been said, is always strongest in the direction of the fibre, and wherever a good strong purchase can be maintained it is best to render it available. Care should be taken not to splinter the surface. No more force should be used than is just sufficient to separate the chip without detaching any adjacent fibre ; in other words the work of carving is to be done entirely by cutting and never by rending.

The carver must have complete command of his tools. He will sometimes find it expedient to use his chisel with the bevelled side upwards so as to cut away a thin shaving, something like that made by a plane, and to avoid entering the wood too deeply. By this means a great deal of carved work can be performed more easily with a chisel than with a gouge.

Chip Carving.—The kind of carving to which the name of "Chip Carving" has been given may be said to be the most ancient decorative work to which the term carving can be assigned, inasmuch as it is the method which is resorted to by the savage in order to give an ornamental appearance to the handles of his weapons, tools, and various implements that he uses in the pursuits of everyday life. A notch made in a stick may be said to be chip carving, and from this it will be at once understood that this kind of work is incised work, consisting in the removal of small pieces from the surface of the material by cutting into it with a small sharp tool suited for the purpose. From simple notching an advance was at first made to the arrangement of notches or incisions in various patterns, distinguished for the most part by the repetition of particular forms in regular order, so as to form a species of diaper work over the entire surface, or a portion of it, as the operator might determine ; but in the present day, great excellence and beauty has been attained by causing the carving to assume the form of geometrical patterns, some simple and some of extreme intricacy, by which the plain surface of a great variety of articles made in wood, such as paper-knives, blotting-cases, watch-stands, frames for pictures and photographs, the edges of the standards and shelves of book-cases, plates and plaques, bowls, and other articles, too numerous to be mentioned here, can be wrought and enriched.

The first thing to be done is to draw the pattern decided on upon the surface of the material or article, be it what it may, to be carved. For this a flat rule, parallel ruler, set squares, and compasses with pencil leg will be required.

In designing the diaper the surface is first marked off in squares

like those of a chessboard, and the squares afterwards filled with diamond shapes, triangles, hexagons or pentagons by drawing intersecting diagonals. In this way a particular pattern is repeated over the whole surface.

Many patterns are easily cut with a single tool; generally the firmer or chisel is used. In some cases lines are cut with the parting tool or smallest gouge. In any case, the work is extremely easy and well adapted to the needs of the beginner, who, by the continuous repetition of a particular process, soon becomes familiarized with the use of his tools.

Appliqué Work.—A ground of diaper work is sometimes further decorated by the application of an ornamental pattern cut out from thin board by means of a fret-saw and wrought with the carving tools, either after or before being glued to the " ground." This process, which is known as *appliqué* work, involves far less labour than that which would be necessary in reducing to a uniform level, the surface around the ornament. In making the diaper pattern a blank flat space of the surface, the exact size and shape of the ornament of which it is called the " seat " is marked out and left untouched by the incising tools or punch. and upon this space the figure is glued. Very handsome panels may be easily made in this way and the process is also suitable for book or album covers. In the latter case, however, it is advisable to protect the central ornament by a framework having a somewhat greater depth than the ornament itself.

Panel Work.—In carving a panel such as that shown in Pl. XXVII, the design is first traced on the surface of the wood and " outlined " by cutting with the V-shaped parting tool a groove round it at a distance of about ⅛ in. The object in making the groove is to prevent the splitting or bruising of the wood forming the ornamental pattern by weakening the fibres in the opposite direction. The design is then " set in " (Fig. 1) by working round it with a mallet and chisel or gouges of which the curves correspond with those of the various parts of the figure, the tools being changed whenever necessary. The cuts made in this way should be of the exact depth of the ground. Afterwards the waste wood must be taken out to a uniform depth, usually about ¼ in., so as to leave the design quite free in bold relief. This should be done by means of flat gouges or grounding tools (Fig. 3). In this operation care must be taken to work as much as possible in the direction of the grain of the wood. This is best shown by

the behaviour of the tool and the smoothness of the cut. Any tendency to splinter should be removed, either by altering the direction of the tool or by changing the position of the work. When cut down to the required depth, the ground or "floor" should be cleaned up with the flattest gouges and given a matt appearance by the use of the punches, to which reference has already been made.

In dealing with foliage, the leaves should first be studied. At the extreme points they have a slight curvature upwards, which, however, is not any higher than the thicker portion, or that which is apparently the thicker portion. Wherever a depression exists in a leaf we must begin by hollowing it out with the chisel, but only very gradually, for we must bear in mind that the surface of the leaf again slopes down from the edges, and it is far easier to cut away too little material, for more can always be taken away, while it is impossible to add any when more than is necessary has been scooped out. Expert carvers would use a gouge with a somewhat flat edge for such work, but less practised hands would find the skew-chisel a more convenient tool. The cutting should be done both ways from the higher surfaces towards the centre of the depressions, following the grain of the wood as much as possible. With such work it is not necessary to observe a mathematical exactness in the outline; a little irregularity often adds to the effect and prevents stiffness of appearance.

The veining-tool must be used for marking the ribs of the leaves, the larger one being made by cutting a double line from the stem, and then gradually merging the two lines into one as we work towards the end and then the lateral or side ribs of a single line joining the centre or mid-rib. These veins or ribs should not be cut deep, but distinct enough to show a clear sharp line. Care should be taken that the outline or contour of the leaves are always devoid of stiffness, and a graceful, natural appearance preserved. Intersections of stems should be neatly worked out, by cutting away a portion of the wood on each side of the under stem where the upper one crosses it. The depression must not be too abrupt, lest it seem like a dent made purposely, but the line of slope should be begun far enough back from the point of junction to allow a harmonious blending, and show a distinction between each stem. The surface of the leaf can be neatly smoothed with the mezzotint scraper, a tool which resembles a double edged desk-knife, which will be found more convenient for the purpose than sandpaper. The stems

should be rounded, but left rough in order to preserve a natural appearance. Sandpaper should not be used for such work as this, and for the few occasions on which it may be absolutely necessary to use it, the carver will find it convenient to cut out slips of rough wood, somewhat of the shape of files, to which strips of sandpaper may be glued A clear, clean cut with the carving tools will, in general, be quite sufficient.

Carving in the Solid.—This work will divide itself into carving in high or low relief, which in either case has a grounding of the same material, from which the carved work rises, and carving an object out of a solid piece of wood every part of which is wrought over by the carving tools. A wreath of flowers hanging between two sustaining points, or a dead bird or animal suspended to a nail or ring, may be taken as a good example of carving in relief; and the finial to the upright end of an open seat or bench in a church, commonly called a poppy head, may serve as a fitting illustration of the other.

In carving from the solid on every side as in the case of a finial or poppy head, the first thing to be done is to trace on the outer and inner faces of the wood the shape that the finial would present in section if cut vertically down the middle. Lines must then be drawn across the sides and by the aid of these and the outlines on the faces the superfluous wood may be cut away, leaving the ornament roughed out. The sides of the finial will be merely plain surfaces with the edges chamfered or cut away sufficiently to give the necessary roundness to either face, which must then be marked in pencil to show the parts that are to be cut away and the parts that are to stand out in relief. The whole must then be finished with gouge and chisel. No attempt should be made in the earlier stages of the work to give any appearance of finish to a part of the carving which should be merely "roughed out" until a good idea of the general effect of the whole has been obtained. In this, as in all other forms of carved work, detail and finish should be left until the whole has been worked up.

In order that the carving should retain its character and spirit, all finishing should be done, as far as possible, with the tools themselves, the need for files and sandpaper being carefully avoided. Carved objects should not be polished or varnished, the only exception to this rule being allowed in flat or ribbon work, where the effect can often be heightened by polishing the

pattern, which rises from the matt surface, and thereby producing greater contrasts in light and shade.

CHAPTER VI

(A) CURVED WORK AND (b) PATTERN-MAKING

Curved Work.—It is often necessary to make curved work in wood as, for example, in the rounded or elliptical front of a chest of drawers, the rounded corner of projecting woodwork in a passage or lobby where a sharp-angled projection might be somewhat dangerous or in the way; the rounded door of a corner-cupboard often in the form of a quadrant or quarter of a circle; and in the flanges of patterns for castings.

Steaming and Bending Wood.—Wood of any kind may be steamed and bent into shape, though certain woods such as ash, oak, birch and elm, are much more suitable for the purpose than others. This is the method generally adopted for curved work in carpentry and joinery, and for bent wood furniture; for when the wood has been steamed, bent into the desired position, and allowed to dry in this form, it will exhibit no tendency to return to its former shape. When a framing of which the curvature is but slight, is required, the rails may be sawn out of a solid piece of wood, and the rails thus made and the connecting uprights then fitted together.

Making Curved Rail.—Thus, if a curved rail were required an inch in thickness and 3 in. in width, the extent of curvature from the centre of the face to the centre of the straight line joining its extremities not being more than 3 in., it is evident that such a curved rail may be cut out of a piece of wood 3 in. wide, and of a length a little more than that of the straight line from end to end of the inner arc of the rail. For working the outer and inner surfaces of such a piece of wood as this, it is desirable to use an adjustable circular plane. This plane can be used for either straight, concave, or convex work.

Rounded Work for Framing.—In the case of rounded work for framing the panel is cut in thin wood, exposed to steam—a good jet from a boiling kettle will often prove sufficient when the wood is thin—and then secured in the frame. The moulding must be treated in a way which will be described presently.

Rounded Corner of Passage, etc.—For work that is permanently

fixed, such as the rounded corner of a passage, another method is adopted. Supposing the corner to be in the form of a quarter of a circle, the shape which for obvious reasons such a corner would most frequently take, a plan is marked out, and boards of the height required are taken and fitted together lengthwise by a groove and slip-feather, the edges being bevelled, so that the section of each board is in the form of a four-sided figure, the two ends of which are inclined to the longer and exterior sides at an angle of 78° 45′ and the inner and outer faces of which are parallel to each other. When the boards have been glued up and allowed to dry, all that remains to be done is to reduce the exterior angles with a plane—a trying plane is best for the purpose, but a jack-plane will do—until a perfectly circular surface is produced.

Curved Work in Thin Wood.—When amateurs have occasion to make any curved work, although they generally take a great deal of trouble, they frequently fail to make a neat job of it. Should the piece to be curved be thin, such as, for instance, the flange of a pattern, one of the two following methods will be found to answer.

Cut out a piece of wood of such a length that will, when curved, occupy the required space. Plane it down to the proper shape and size, and then with a tenon-saw make some saw-cuts in a vertical direction all on one side of the wood, and rather more than half-way through it. It is manifest that the substance of the board or even its length from end to end is reduced on the side in which the saw-cuts have been made to the extent of the aggregate width of the cuts, and if pressure be applied to the ends of the board to bring it into a curved form, the edges of the saw-cuts will be brought together, the fibres of the wood in front being slightly strained in order to accommodate the wood to the new form. The smaller the radius of the curve, or, in other words, the greater the degree of curvature given to the wood, the nearer together and the more numerous must be the saw-cuts. Of course, the wood by being treated in this manner, is much weakened, and the method is therefore unsuitable when strength is required. It is, however, often used for light, open-work patterns when only a few castings are to be made from them. The amateur will find it chiefly useful in forming curves when putting down wooden border edging of no great thickness, and in making a bowed front to a box for plants when the window for which the box is intended

is a bow window having a curved or circular front. A curve made in this way—provided that the wood is afterwards brought into contact with no moist substance, such as the earth in the window-box—may be rendered stronger by laying the piece of wood flat upon the bench with the cut side upwards, then rubbing some strong glue into the cuts, bending it into the required shape and gluing a piece of canvas over the cut side. When dry it will retain its shape and stand rougher usage than it would before. The canvas will, in a great measure, prevent the wood from snapping at any one of the saw-cuts as it is otherwise liable to do, especially if the saw-cut has been carried a little too deep into the substance of the wood.

It will be seen, however, that the curve made in this manner will not in any case be a portion of the circumference of a true circle, but will consist of a series of small flat surfaces. If the saw-cuts are very close together, the flats will be small, and practically will not make much difference; but if the saw-cuts are a good distance apart, they will be large enough to unfit the curve for nice and particular work.

Curved Work for Castings, etc.—A method far preferable to the foregoing, when the curved work is to be made for patterns of castings, is to get a piece of good ash, this wood being better adapted for work of this kind than any other on account of its elasticity, and after planing it down to the required size and shape, lay it in a wet place, in such a position that the part intended for the *outside* of the curve only may get wet. When the water has soaked into it, remove it from the damp and hold the inside close to the fire. As it gets warm, gently and gradually bend it to the curve. By the time the outside is dry it should be bent into the shape, but if it should happen that the outside is dry before the bending process is finished, a wet cloth should be drawn along over the outside, after which heat and gentle force must be again applied. When very acute curves are required, they should be carved out of a solid and sound piece of wood. Alder is generally used, and answers well. A great deal of time and trouble is saved in this sort of work by the use of the bow-saw or, in the case of thin wood, the fret-saw. Thin curved pieces of board, are cut to shape by means of the cross-cut saw, key-hole saw, or any narrow saw that may be worked in accordance with the curves.

Construction of Thick Curved Shapes.—When curved shapes are

required too wide and thick to be bent and too large to be cut from a solid piece, they must be built up of separate pieces, each piece being similar in form. When done in this way it is not liable to warp. To build up a piece of curved work in this way, the circle or curve should first be drawn on a piece of board that has been planed true and even. The first layer of pieces, previously cut out with a saw adapted for this kind of work, and planed true on one side, must be pegged on the mark with wooden pegs or pins. The top side must then be planed true and another layer glued and pegged on the top of the last in such a manner that the middle of each section comes over the joints of the last layer or, in other words, each layer must break joint with the previous one. After the construction is finished and the glue dry, if the curve is but a small portion of a circle, or if it is not a true circular curve, it must be lined out with compasses and brought to the correct shape by means of planing. If, however, it is a circular ring, difficulty will be experienced in finishing it off in this way, though the operation can be performed with ease in a turning-lathe.

Curves made both of thick and thin wood are often required in pattern making, most patterns having some curved work about them ; a pattern with *all* straight edges has a very ugly appearance, and when practicable, therefore, curved lines are introduced.

Pattern-making.—The words "patterns" and "pattern-making" have been made use of several times in the last few pages. When a particular shape is required in cast metal of any sort, such as iron, brass, gun-metal or lead, it is first necessary to construct in wood a model, or *pattern*, of the same shape and size as the article required in metal. One pattern will do for a great number of castings, but every different shape, or different size of the same shape, must have a pattern made before a casting can be obtained. Pattern-making therefore, is an important branch of woodwork. It is, indeed, a trade by itself, and in all large engineering establishments a number of men are always employed in making patterns in wood to be afterwards used to obtain metal castings.

Amateur should make his own Patterns.—If it is the intention of the amateur to go further than the mere application of the wood-working art to ornamental purposes, and others for which a knowledge of ordinary carpentry and joinery is suffi-

cient, and to become practically acquainted with the manner of working metals in the construction of models of machinery, etc., then he should be able to make his own patterns. To do so, most of the joints and other operations already described will be called into requisition ; in fact, to make most patterns very little more knowledge is required than that which the reader has already acquired.

In small models of machinery it is often the case that the weight of the model is hardly sufficient to keep it firm on its legs or supports, and sometimes also the maker may desire to polish the whole of the surface of the model ; in either of these cases, the pattern and consequently the casting, must be made solid with flat surfaces and the same thickness throughout the width. On the other hand, whenever lightness is required, the frame of the pattern is made about one-third the thickness and is strengthened laterally by means of thin strips about two or three times as wide as the thickness of the frame. These strips or flanges are nailed or otherwise fastened to the edges of the frame. In the casting the frame and flange are in one piece without joint or seam, and the casting is nearly as strong as, and much lighter than the same shape would be if cast solid. A flanged casting has a much better appearance than a solid one, but the pattern is more difficult to make. The pattern must when built up be well rubbed with glass-paper ; all the holes, cracks, and irregularities of any kind must be stopped with putty ; and the whole varnished with shell-lac varnish, or well rubbed with black lead.

Forms which will produce sharp edges should be avoided as much as possible, because these edges are very liable to be knocked off when the molten metal is poured into the mould. Should glue have been used in making any pattern, or grease in any way rubbed about it, care must be taken to clean it off thoroughly before the pattern is used, otherwise in moulding the sand will adhere in any places which may be covered with greasy or sticky substance, and a bad casting will necessarily result.

Both sides of a pattern should not be exactly square, but one should be very slightly tapered off to allow the pattern to be removed from the sand without spoiling the mould.

Contraction of Castings.—In cooling from the molten to the solid state the metal of which the casting is made contracts, and this fact must be taken into consideration in making the patterns. The extent to which the pattern should be made larger than the

casting depends largely upon the kind of metal to be used. Iron shrinks about $\frac{1}{10}$ of an inch per foot, brass $\frac{1}{5}$ of an inch or twice as much as iron, steel and aluminium from $\frac{1}{4}$ in. to $\frac{5}{16}$ of an inch per foot. In making the necessary allowance for shrinkage it is always well to "play safe" by being liberal rather, than otherwise. When machining has afterwards to be done on the casting, the margin must be still further increased. In the case of iron castings of fair size, the usual allowance is $\frac{1}{8}$ in. for outside machined parts, and $\frac{3}{16}$ n. for inside work. For small brass castings of sound metal $\frac{1}{16}$ in. and $\frac{1}{8}$ in. respectively should be sufficient.

Holes in Castings.—Castings are often required with holes through them. When this is the case, the pattern is generally made solid and two pieces of wood called "prints", the size and shape of the required hole, are affixed to it, one piece on each side of the pattern on the place where it is desired to have the hole. This plan when adopted saves a great deal of trouble, but it cannot always be followed, and sometimes it is more trouble to cut out two prints than to make the hole or opening in the pattern. If the amateur should make his own casting, and prints have been used, he will know when holes are intended to be made, but if the pattern is sent to a foundry, the word "print" must be written on the parts intended to be used as such, as unless the founder knows the purpose of the casting, the prints will be cast solid as projections.

Core-Boxes.—When it is wished to have a hollow casting, or a casting with holes in it larger inside than at their orifices, the pattern must have prints affixed to it the size of the orifices. For such a casting a "core-box" must be made in two parts, each of which has an opening cut in it of the shape and size of half the internal size of the casting and half the print. The use of this core-box, which must be sent to the foundry, is to enable the iron founder to mould the core.

It will be sometimes necessary to make a pattern in several parts, so that one piece can be removed from the mould at a time, and in some cases the pattern cannot be removed from the mould without burning it out. This, however, seldom occurs, but when it does, it will of course necessitate the making of a fresh pattern for every casting.

A sudden and great change of size of the component parts of the pattern should always be avoided in pattern making. This cau-

tion should be particularly attended to. In wheel patterns with heavy rims and bosses, the arms should be proportionately large, or they should be slightly curved; otherwise, when the metal is poured into the mould, the small parts will get cold and contract much faster than the large, and in contracting will break away from those parts which from their size are still hot, and consequently have not contracted to the same extent.

CHAPTER VII

SIMPLE AND EASY CONSTRUCTIONAL WOODWORK

The method of making joints in woodwork by mortise and tenon, by dove-tailing and by halving, have been explained in Chapter V of the previous section of this work and the amateur, having learned to saw and plane wood with a fair amount of skill and having made himself familar with the use of the various tools, commonly used by carpenters and joiners, is in a position to proceed to the making of many simple articles which are necessary or useful in every household.

Frames for Pictures.—For the internal decoration of the home, it will be difficult to find any kind of work more pleasing than picture-frame making; pleasing, because good results may be speedily obtained at little cost and with a small amount of labour; and profitable, because pictures, of whatever kind they are, whether engravings, water-colour drawings, or oil paintings, as long as they are good, form wall decorations of which the eye never grows weary and in which some fresh attraction is always to be found. Mouldings of any kind may always be purchased ready for use, and all that remains to do is to cut them to the required lengths, mitre them and fix them together.

Before going into the method of cutting out the pieces for the picture-frames and putting them together, it may be well to point out that for engravings, mouldings of oak or other plain wood with a slight gold bead within the moulding are suitable, while, for coloured pictures of any kind, gilt mouldings will generally be preferable. For water-colour drawings and chromo-lithographs in imitation of water-colours, a slight moulding is sufficient, and the picture itself is seen at its best when placed within a wide "mount", or large piece of cardboard of some thickness with a piece cut out of the middle so as to show the picture and having the edges bevelled and gilt. Oil paintings and reproductions of

them, on the other hand should be fitted directly into the rebate of the gilt frame. The amateur will find it difficult to cut a mount for himself satisfactorily, but these can be obtained at various prices according to size from the print-seller or mount-cutter. The glass, which should be thin and of good quality, can be procured from the print-seller or the oil and colour shop. The variety of mouldings is so great that it would occupy far more space than can be spared to give any description or list of them. It will suffice to say that they are sold by the foot, and that they vary in price according to the width and ornamentation of the moulding. Illustrations of some of the patterns obtainable are given in Plate A. Mouldings of foreign manufacture are cheaper than English mouldings and are equal in appearance, but the latter have the merit of being more durable and the gilt is not so liable to tarnish.

For making his picture-frames the amateur will require a fine tenon-saw, a mitre-box, and a clamp for keeping the corners of the frame in position while he is engaged in nailing them together. If he has not the first-named tool in a small size, that is to say from 6 in. to 8 in. in length, he should provide himself with one. A mitre-box, better fitted for the purpose than the mitre-boxes used by joiners and carpenters for ordinary work, may easily be made; and a clamp, or contrivance to act as a clamp, for keeping the parts of the frame in position while being glued and bradded together, may be constructed with as little difficulty.

The actual method of mitring the corners of the frame together has already been explained in the chapter on "Joints" (see p. 1), It is evident that the picture-frame maker's first care must be to cut the pieces of which his frame is to be made and plane the ends up at a bevel which shall insure exactness in mitring when the pieces are brought together at the corners of the frame.

To do this with the precision that is necessary, a mitre-box must be provided (Pl. XVIII, Fig. 1). The ordinary mitre-box will be sufficient for the experienced professional maker, but for the amateur's use one of a somewhat different structure is desirable, that will serve as well for planing up the ends as for cutting them. This mitre-box is made of two pieces of sound straight-grained deal, each being about 1½ in. thick, 9 in. wide, and 2 ft. long. These pieces of board are firmly screwed together, the edge of the upper piece being set back 4½ in. from the edge of the lower piece so as to form a wide rebate in which a trying-plane may be pushed backwards and forwards as may be necessary. Next, take two pieces

of wood about 2 in. in width, $1\frac{1}{2}$ in. in thickness at the least, and 12 in. long, cut them at one end accurately to an angle of 45°, so that they may meet together in a line, which is at right angles to the edge of the board. Now it is clear that if the ends of the two pieces are planed up and brought just so close together in this line so that a saw blade will pass between them and not more, if a piece of moulding be laid along the edge of one of the battens and cut, the edge of the saw passing through the saw-kerf, acting as a guide line, the end will be cut at the proper bevel. This may also be done if the *square* end of a piece of moulding be laid in the angle, in all other cases the moulding must be laid against the outside edge. It should be held in position against the batten by one or two small clamps, which will save the trouble of holding the moulding when cutting it and ensure better, neater and truer work. To plane up the bevelled ends of the pieces of moulding, all that is necessary is to lay each piece against the outside edge of the batten which will give the required angle, right or left as may be necessary with the bevel, parallel to and almost coincident with the edge of the board, and then pass the trying-plane along the rebate against the edge until the end is sufficiently planed down. The iron of the trying-plane should be set fine and well sharpened on an oil-stone. A simple and effective method of holding the four sides of the frame together, whilst gluing up the corners and securing them with brads may be made in the following manner. A piece of board about 1 in. thick and large enough to take a good-sized frame, say 3 ft. by 2 ft., should be clamped at the end to keep it from warping. In place of a board the top of the bench, if it be clean and perfectly level, or a kitchen table or any small deal table, the top of which is in one piece, will do equally well. (Pl. XVIII, Fig. 2). The advantage of having a board for the purpose is that its edges can be planed perfectly square and true. To prepare for putting the frame together, first set off and lay out an area exactly the size of the picture-frame, marking its limits on the surface of the board. These lines should coincide with the outer edge of the frame. Along the lines of two adjoining sides of the figure marked on the board should be screwed four small blocks, two on each side. Four other blocks should be similarly screwed about $\frac{1}{2}$ in. from the lines forming the other two sides. Having glued the ends of the pieces forming two sides of the picture-frame, these pieces should be fitted together and placed so that the outer edges are against the blocks screwed down on the lines.

The other two pieces should then be glued and placed in position, and the frame locked together by means of folding wedges driven in between the sides and the remaining blocks. The frame must remain locked up until the glue is set, when the wedges may be removed and some thin brads driven in at each corner to strengthen the frame.

To save trouble, instead of the blocks, first fixed to the boards, it will be better to have two slips of wood permanently screwed to the surface along the edges. It will then only be necessary to set off the lines against which the other two sides of the frame will come with the T square, and screw down other blocks a little to the outside of them, so as to allow of the insertion of wedges for locking up the frame. Again, the wedging-blocks may be dispensed with altogether, and two clamps substituted for them. The screw of this clamp should work into and against a block through which its pressure is transmitted to the frame, and also in a block fixed to the edge of the board. This block is notched to receive the edge of the board or table, and is fitted with a thumb-screw below, by which it is fixed before pressure is applied to the picture-frame. The amateur will not find any very considerable difficulty in making clamps of this kind for himself, or adapting others to serve the purpose in view.

From the ordinary picture-frame we must pass on to the "Oxford" frame, the peculiarity of which is that the ends of the four pieces of which it is made, instead of being mitred together, in rectangular corners, project each beyond the other in the form of a cross. Lengths of oak, properly rebated, may be obtained for making these frames, but the amateur may make them for himself without assistance of this kind, and instead of oak he may use deal, which he can afterwards stain and varnish or French polish, or blacken in imitation of ebony, according to taste.

For the purpose of making such a frame, four pieces of wood will be required about 1 in. square when planed up. These pieces are all halved at suitable distances from the ends, the perpendicular or side pieces being cut to half their thickness in the under surface to fit over the end pieces, these being cut to the same extent in the upper surface so as to receive them. The edges of each piece are stop chamfered. Small brass bosses or studs are generally inserted at the intersection of the pieces to give an ornamental appearance to the frame.

If the amateur has a rebating plane (see p. 49), he will easily form a rebate in the inner edge of the under part of each piece ;

or after the frame is put together, before gluing up and pinning, the rebate may be marked and cut out with a chisel, the pieces being taken apart for the purpose. But, instead of doing this, pieces of wood of sufficient thickness to receive glass, picture, and backboard, may be cut out and glued or nailed to the under part of the frame. Similar pieces of wood may be attached to either the vertical or horizontal pieces from end to end throughout; but in the others, whichever they may be, the rebate will be completed by putting on narrow strips between the pieces thus fixed, and pieces of the width of the frame on to the four ends to make the thickness the same throughout the frame and secure uniformity in this respect.

Clothes-horse.—As a preliminary exercise, and before proceeding to large work a suitable exercise for the beginner in woodwork involving the use of only the saw, plane and chisel will be a small clothes-horse. For the uprights, four pieces of stuff, yellow deal will serve very well, 2 ft. 10 in. by 1¼ in. by 1 in. will be required, and for the cross-rails, six other pieces, 1 ft. 8½ in. by 1 in. by ⅝ in.

The framing may be sawn out of 1 in. board, but if machine-planed stuff is used the thickness of the uprights will work out at something less than the inch. The parts of the frame should first be cut to the required length and planed up perfectly square. A finish should be given to the appearance of the uprights by rounding off the tops. The cross-rails should be tenoned into the uprights at distances of 10 in. from the bottom. This will bring the top of the upper rail 1 in. from the top. The tenons, which should be ¼ in. thick, should be taken right through the upright and wedged on the face side. Allowing 1¼ in. at each end for this purpose the length of the cross-rails between the uprights will be 1 ft. 6 in The two frames may be joined, either by means of a pair of small brass hinges fixed about 6 in. from the top and bottom respectively or, in accordance with the plan more usually adopted, by nailing on pieces of strong webbing.

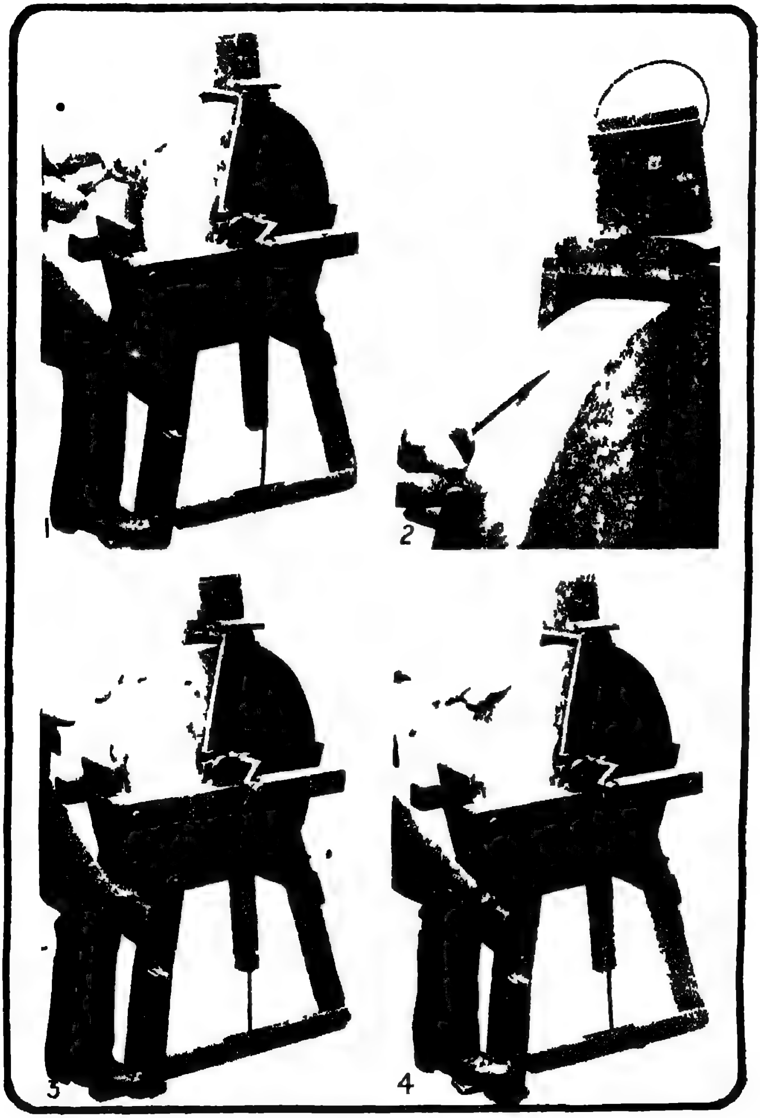
Blind-roller.—Blind-rollers can be bought, generally speaking, of the oil and colour man, with the fittings for the ends, at prices varying according to length; the amateur, however, can, without difficulty, make them to suit his particular requirements. A straight-grained, clean piece of deal having been selected, about 1 in. or 1¼ in. in thickness—it must not be thicker—a piece just as wide as the wood is thick and of the necessary length must

be sawn off. The transverse section of this piece of wood will be a square, and the four arrises or sharp edges must then be planed off, so as to make the wood octagonal or eight-sided instead of square; before doing this, however, the sides of the wood should be planed up. To hold the wood whilst it is being planed, a V-shape trough should be formed by sawing down a square piece of stuff diagonally, and fastening the two pieces thus obtained down to the bench with their sharp edges against each other. Another plan is to chamfer one edge of each of two pieces of wood and nail these two pieces together so that the required groove is formed by the chamfered edges. A small piece of wood should be nailed in the groove at one end to act as a stop. The square piece of wood from which the roller is to be made may then be laid in the trough with one of its diagonals in a vertical position and the angles planed off one after the other until an octagonal section is obtained. It is not necessary to make the roller round, but the amateur can do this if he prefers a round bar to an octagonal one. Each end of the roller must then be *keyed*, in order to fit into square holes cut for their reception in two pieces of hard wood, one of which is thin and the other grooved like a pulley. The object of the *keying* is to prevent any chance of the grooved end being turned round by the blind cord without carrying the roller round with it. The plain end should be attached to the *left-hand end* of the roller, and the grooved end to the *right*. Brads may be driven through the ends to fasten them more securely to the roller, but if the keying has been properly done this will be unnecessary. Two pieces of strong iron wire must then be driven in, one at each end of the roller, to serve as pins on which the roller may revolve. Care should be taken to drive these precisely into the centre of each end, and in such a manner that the two pins may be exactly in one and the same straight line. If they are not so the roller will not revolve easily, but have what is termed an *eccentric* motion.

The fitting of the blind and the fixing of a blind-roller will be dealt with in a later chapter (see p. 284).

Curtain-poles.—Curtain-poles may be made in a manner similar to that adopted in case of the blind-roller, but the wood should be from $1\frac{1}{2}$ in. to $2\frac{1}{2}$ in. in thickness, and the pole should be made perfectly round. After an octagonal section has been obtained as described above, the corners should again be removed, and sixteen equal sides found. The process should then be repeated with a smoothing plane set fine, or a wide

Plate XV THE GRINDSTONE



1 Chisel [illegible] Screwdriver [illegible]

Plate XVI SHARPENING TOOLS

(1 and 2) Sharpening cabinetmaker's scraper (3) Removing wire edge from plane iron (4 and 5) Sharpening gouge with oilstone slips (6) Sharpening spokeshave iron

hollow plane, until the pole is nearly round when it may be finished with glass-paper. The pole should be about 3 in. longer at each end—that is to say 6 in. altogether—than the extreme width of the window. When it is finished, ornamental ends, either turned in wood or of brass, should be affixed to it.

Whether made of deal or beech, curtain-poles should be stained and French polished; they should not be varnished, because a varnished surface is more liable to injury from the backward and forward movement of the rings than a French polished surface. The instructions here given apply entirely to straight curtain-poles. When curtain-poles are required for bay-windows, unless a straight pole of considerable length is used, stretching across the whole width of the bay, they must be *moulded*; that is to say, composed of three pieces, joined at an angle corresponding to the angle formed by the inclination of the side windows to the front window. This is a very nice piece of work, and unless the amateur is a skilled and practised joiner he had better leave it to the professional cabinet-maker.

Kitchen Table.—The ordinary kitchen table is a good type of the square or rectangular table, and if the amateur can make a piece of furniture of this description he will have no difficulty in introducing such modifications as may be necessary in the construction of the more highly finished article of a similar form required for use in the dining-room or bedroom. It will be understood, however, that tables which can be lengthened or shortened at pleasure, such as telescopic dining-tables do not come within the scope of our present work; their construction being too complicated and requiring too much space and too much illustration for description here. A telescope-table must be studied in all its parts and movements before any attempt can be made to make one.

In making a kitchen table we have to consider, first, the supports or legs; secondly, the rails by which the legs are connected; and, thirdly, the board or top which is laid on the frame formed by the legs and rails, and which completes the table. In Pl. I, Fig. 1, the elevation of one side of a kitchen table is shown and in Fig. 2, the plan of the framing made by the legs and connecting rails, or rather a part of it, as it is unnecessary to give the whole, for by the aid of the diagram the amateur will be able to make a complete plan for himself according to scale. The figures here given are not drawn to scale, for reasons that have been already stated. The legs should be made out of

pieces of good red deal at least 3 in. square when planed up. "Table height" is reckoned to be 2 ft. 4 in. or 2 ft. 5 in., reckoning from the floor to the surface of the table; the former is the more convenient height for general purposes, but as much work on a kitchen table is done in a standing posture, it is better to have a table of this kind an inch or two higher. Supposing that the slab or board which forms the top of the table is 1½ in. thick, the length of the legs will be 2 ft. 3½ in., supposing the table to be 2 ft. 5 in. in height. It will be noticed in Fig. 1 that the legs are bevelled or sloped slightly on the *two* inner sides to give a lighter appearance to the table when finished. The rails may vary in depth from 4½ in. to 6 in., according to the length of the table; for the amateur will remember that the longer the joist or rail, the deeper it must be in order to prevent deflection under any superincumbent weight. The legs may, if desired, be kept square as far as the depth of the rails, but from the bottom of the rails or a little distance below it the legs may be bevelled as drawn. The rails are cut at each end in double tenons as shown in Fig. 1A. These tenons fit into mortises cut in the interior faces of the tops of the legs, as shown in Fig. 2, the shorter part of the tenon going only as far as the lines drawn across the tenons in the diagram, and the longer part entering the leg to the full depth. When the legs and rails have been accurately fitted together, the tenons are glued and driven home into the mortises, and secured with wooden pegs. The amateur is advised never to put a nail through a mortise and tenon joint, especially in making furniture, for a wooden pin can be easily bored out with a gimlet or stock-and-bit, while the extraction of a nail will tend more or less to the injury and consequent disfigurement of the wood. The value of this advice will be acknowledged when the amateur finds it necessary to put a new rail into a table.

The framing being all ready, the top may be placed on it. This must be made of boards securely jointed together by one or other of the various modes adopted for this purpose, and which have been fully described (see p. 109) and clamped at the ends in order to prevent warping. The top or upper surface must be planed smooth; the under part may be left rough if preferred, but the plane should be passed over the edges and the under surface where it overlaps the sides, which it should do for about 3 in. The top may be fastened to the framing by means of screws; notches should be cut in the inner side of the rails and the screws driven upwards in a slanting direction. This can only be done when the rail is a substantial one. In slighter

tables the top is usually nailed down to the frame, but in larger tables of this kind it is useful to be able to remove the top at pleasure. Sometimes a deep groove is ploughed in the inner part of the rail, and a button with a short projecting flange is screwed to the under surface of the top of the table. The button turns on the screw, and the flange may be turned in or out of the groove at pleasure. There should be a button at least at every foot all round the table. When the top of any table of this kind is a fixture, it is generally "blocked;" that is to say, rectangular blocks of wood are glued at short intervals into the angle formed by the meeting of the under surface of the top and the inner surface of the rail, to give additional strength and stability to the structure.

It has been shown that the component parts of the kitchen table are the legs, the rails at sides and ends and the top; and it has been further shown how these various parts are to be put together. The principles of construction which have been followed in making and putting together these parts enter into and govern the making of any kind of table or support used after the manner of a table as, for example, a washstand or dressing-table. The back of either of these, the sides connected with the back, the frame and shelf of the washstand, the drawers with which it is sometimes fitted, and other additions are merely modifications or extensions of the same principles, which the amateur will be able to reduce to practice and carry out after an inspection of any article of furniture of this kind that he may wish to make or repair, and a due consideration of the relation of its various parts.

House-steps.—House-steps are at one time or another a necessity in every household. Pl. J, Fig. 1, shows the elevation of the steps when extended and viewed from the side. To make these steps two pieces of wood, 4 in. in width and 1 in. thick, and of a length according to the requirements of the amateur, but not more than 6 ft., as the general length or height of steps of this description ranges from 2 ft. 6 in. to 6 ft., must be first selected, and cut on a bevel at top and bottom, as shown by A B in Fig. 1. This bevel may be found by setting one end of the board on the floor, inclining it to the angle which it will make to the floor when the steps are extended, and by the aid of a spirit-level drawing a horizontal line across the board. A bevel should then be set to the line and used for marking off the pitch of the steps as well as the angle of the top and bottom of the sides. Grooves 1 in. wide, to receive the

ends of the steps, must then be cut, from 6 in. to 9 in. being allowed from the bottom of the piece to the under side of the lowest step, and 9 in. clear between the steps—that is to say, from the upper surface of each to the under surface of the one above it. From ½ in. to ⅝ in. is deep enough for the grooves. The upper ends of the sides should be mortised into the top step which must be wide enough to project over the piece L which is nailed, or screwed to the sides at the back directly under K as shown in Fig. 2. As soon as the sides, the top and the steps are all ready, the front part may be fitted together and secured with nails or screws. If desired, tenons may be cut on each side of the steps to fit into corresponding mortises cut in the sides in addition to the grooves; but this is not absolutely necessary; the top step K, however, must be mortised to the sides. The top edge of the front of each step laps slightly over the sides. The corners should be rounded off with the chisel after the steps have been put together.

As soon as the front has been put together and properly fastened, the piece L must be put on, and a frame made consisting of two upright pieces and two rails.

The wood of which this frame is made should be 1 in. in thickness, but the length of the pieces Q and R shown in Fig. 2 and also of the rails, will depend on the height of the steps and the width of L. From 2 in. to 2½ in. will be sufficient for the width of the pieces Q, R, and the bottom rail, but the rail S should be 3 in. or 4 in. in width. This frame when made must be attached to L by a pair of hinges. A pair of 1½ in. or 2 in. butts will be found suitable, or what are termed back flap-hinges may be used, but these must be laid on the outside of the piece L, and the rail S, and screwed on to them as shown in Fig. 2. Lastly, means must be taken to prevent the frame at the back from extending too far from the front part of the steps when opened out. This is accomplished by boring holes in the sides of the front and the side pieces of the frame, as at T and U in Fig. 1, and passing a piece of stout cord through them, making a knot at each end to prevent its withdrawal.

Light Ladders which are similarly made are sometimes required for use within doors, and as these are sometimes placed against bookshelves, windows, etc., to guard against any injury from the ends of the side pieces, a piece of wood about 18 in. long, and from 3 in. to 4 in. wide, should be attached to them at the top of the ladder, as a long shield running from side-rail to side-rail

in a horizontal direction, and extending some inches beyond them on either side.

Combined House-steps and Chair.—The construction of the combined house-steps and chair is clearly shown in Pl. J, Fig. 3, and any skilful amateur may make this piece of furniture for himself by the aid of the diagram. It will first be necessary to note that the step-chair is formed in two parts and that the dimensions of each part must be carefully studied in relation to the other, so that the contrivance may work properly when made. With regard to the construction of the lower portion, which forms the whole base of the chair, but only part of the base of the steps, the stuff used for this step-chair should be good deal or pine, 1 in. in thickness, but thinner stuff may be used for the rails, whether they are simply screwed into the uprights that form the chair back and long legs of the steps, as shown in the drawing, or mortised into them, which will be found more convenient. Two pieces of wood 15 in. long and 4½ in. wide must first be planed up; these will serve, one for the front part of the seat of the chair as shown at A, and the other for the lowest step of the steps as shown at B. Of these pieces B is notched and mortised at the ends, so as to receive and project slightly beyond the side-rail C D, which is 18 in. long and 2½ in. wide. The upper end C of each side-rail is mortised into A, which also receives the end E of the leg E F, which, with its fellow at the other end of A, supports the front of the chair. The side-rails and uprights are connected by horizontal rails as shown at G, and it will add to the strength of the frame if a cross-rail be placed between the uprights at H. The lower part of the structure is now complete, and it remains to make the upper part, which, when finished, is attached to the lower part by strong butt-hinges as shown at K. To make this upper part, two pieces of wood, L and M, must be planed up. Both of these must be 15 in. in length, but L must be 9 in. and M 6 in. wide. L is notched to receive at Q the upright O P, which is mortised into M at O. The pieces L and M are further connected by a side-rail N, which must be cut rather more than 9 in. long to allow for tenons, and the upright O P and its fellow are further connected and strengthened by cross-rails R, S, T, which, as it has been said, may be simply screwed to them or mortised into them. The upper part turns on and over the lower part by means of the hinges by which the boards A and L are connected. When the upper part is turned over the lower part so as to form a set of steps, the board

L forms the second step, and M the upper step ; when it is turned back so as to form a chair the board L forms the remainder of the seat of the chair, while the board M turns on to and rests on B, giving additional strength and solidity to the chair when the structure is used as such. The position of all parts of the upper part of the steps when turned so as to form the back of the chair is clearly indicated by the dotted lines, which are lettered to correspond with the various parts of the top, as shown by the solid lines to the right of the figure. When finished the step-chair should be stained of a light or dark colour, according to the taste of the maker, and varnished.

Plain Wooden Chair (Pl. I).—In the construction of chairs as in that of tables, the principal point is to secure the greatest possible degree of firmness and stability. The making of a plain wooden chair suitable for use in the workshop or garden will enable the amateur to understand clearly the general principles which enter into the construction of most other chairs, and also to repair his own chairs when they are broken.

In a chair, the chief parts of the structure are those which form the back, front and seat. The legs in front and behind are connected by two or more rails which serve as the sides. In order to complete the chair, the framework of the seat must be furnished with a board or bottom of some sort.

Taking the back first (Fig. 6), it will be necessary to cut out two slightly curved pieces of wood about 2 ft. 10 in. long by 2 in. wide from a board 1½ in. thick. These pieces will be joined together by rails to form the back and two of the legs of the chair, and the effect of curving them is to cause the legs to project outwards from the back of the seat and so add to the stability of the chair. The two upper rails should be about 3½ in. wide, and cut out from ¾ in. stuff. This should be tenoned into the sides about 1 in. and 8 in. respectively from the top. The lower rail, which should be round, should be fixed about 6 in. from the bottom. The length of the rails between the sides should be 12 in. About 18 in. from the lower ends of the side pieces grooves ¾ in. in depth should be cut in the front, for the reception of the back rail of the framing of the seat, which is secured in position by driving in a hardwood peg. The framework of the seat should be made of 1 in. stuff mortised and tenoned together, the sides and back rail being 2 in. and the front rail 3 in. wide (Fig. 4). The back rail of the seat framework should correspond in length with the framework forming the back and

legs of the chair, but the front may be about 2 in. wider. The two front legs should be about 2 in. square.

The back, front, and seat being ready, holes must be made in the under part of the front rail in order to receive the upper ends of the front legs, which are cut in the form of pegs to enter the holes (Fig. 7). Two rails are also made in order to connect each front leg with the corresponding leg behind, and to give additional stiffness to the chair. The front and back, it must be understood, have already been securely glued and clamped, and all that now remains to be done is to glue the notches in the back, the holes for the front legs and for the ends of the rails at the sides, and then to drop the seat into its notches, and over the pegs of the front legs, and the rails into their places, and bring the whole firmly and closely together by the aid of clamps. Lastly, the seat may be made by boarding over the seat-frame, or by inserting strips of cane interlaced, to give support one to another, and forming a strong but elastic net-work.

Windsor or Kitchen Chair.—In the wooden chair, known as the Windsor or kitchen chair, the construction differs slightly, inasmuch as no framing is required for the seat, which consists of a solid piece of wood slightly hollowed out, in order to render the seat more comfortable for the sitter. The legs are inserted in holes bored for their reception in the under part of the seat, and the back, which is formed in a variety of ways, is dropped into mortise holes cut in the seat to take the ends of those pieces which form the uprights of the back. No description of the Windsor chair is necessary here as an examination of one will fully explain its construction. It is, to describe it roughly, nothing more than a flat piece of wood almost square in shape, raised on legs and furnished with a back. It is, in fact, little more than a simple stool with a back attached to it.

Chairs, Principles of Construction of.—However varied the ornamentation or form of the pieces of which the chair is composed, the principles of construction will remain much the same throughout. Thus in the ordinary cane-bottomed chair the front of the seat is rounded in shape, approaching very closely to the arc of a circle, while the side-rails that connect it with the back-piece of the seat are slightly serpentine in form. This is merely a modification of outline, the general principles of construction are in no way altered or departed from.

In connexion with the making of a chair it may be mentioned

that there is a "chair height" as well as a "table height," which governs the height of all ordinary chairs above the ground. When the height of a chair is spoken of, the height of the surface of the seat above the ground level or floor is meant. Chair height for an ordinary wooden chair is 17 in., the measurement being taken from the ground to the upper surface of the front rail of the seat. Easy-chairs and lounging-chairs are slightly lower, music-chairs higher. The seats of ordinary chairs are level; but those of easy-chairs are generally lower behind than in front to admit of a slightly reclining position for any who may occupy them.

Armchair.—The most comfortable kind of chair that can be devised is the old-fashioned armchair, with a seat of webbing, sustaining a thick and comfortable cushion, and padded sides, arms and back. A chair of this kind may sometimes be picked up at a furniture sale and cleaned, re-stuffed and repaired, but, failing this, the amateur may make one for himself without much difficulty. It is better to make the frame out of a harder kind of wood than deal. Beech is the best wood, but if beech cannot be easily procured and if, when obtained, the amateur finds it somewhat difficult to work, good red deal can be used instead. The first thing to be done is to cut out the timbers that form the back legs and the sides or chief supports of the back. The part below the seat should be made considerably thicker than the part above. This will allow of a projection for the support of the side-rail of the seat which is mortised into it. The tenon may be carried through the upright or only enter it to a certain depth, but generally it will be better to carry it right through. The rail should be made somewhat thicker in front than behind in order to give a due slant or fall to the seat, by causing the upper surface of the rail to slope gently from front to rear. The lower surface is perfectly horizontal, so that the front leg may be perpendicular. This leg may be plain or ornamental. It is usually turned and is screwed into a square block which in its turn is attached by means of screws to the bottom of the side-rail. The rail forming the arm-rest is mortised into the upright about 10 in. above the framework of the seat; it is of the same thickness throughout and should be perfectly level. A short upright which serves as a support connects it with the seat framework. The sides of the chair are connected by cross-pieces at front and back so as to complete the framework of the seat, and similar rails connect the uprights of the back, one

being placed near the top and the other a little above the level of the arm-rests. The actual seat of the chair is a movable cushion of some thickness, but the support for the cushion is obtained by nailing strips of webbing in the direction of the width of the chair and parallel with the front and back rails of the seat, and interlacing them with other strips of which the ends are nailed to the front and back rails respectively of the seat. The webbing thus nailed on affords a strong and elastic support for the cushion.

The arms and back are generally well padded inside, canvas being nailed neatly over the outside of the chair, over each side, and over the back. To keep the padding in its place, the sides and back may be sewn with a long packing needle, the string that is used being passed through patches of leather, circular in form, to keep the string from cutting through the canvas or hessian with which the framework of the chair is covered. Chairs of this kind are generally covered with an overall of chintz or cretonne.

It may be added that ornamental turned legs for armchairs or couches may be bought at the turner's or upholsterers, ready made, if the amateur is not possessed of a lathe in which he may turn them up for himself.

Writing-table (Pl. I).—A simple method of making a writing-table or occasional table is that of supporting the table-top at each end on legs crossed in the form of the letter X, after the manner of the stand that is used to support a butler's tray, but constructed so as to be rigid instead of movable. Writing-tables and library-tables are generally narrower in proportion to their length than ordinary tables supported on four legs; they have, however, when the legs are crossed, this inconvenience, that it is not possible for persons to sit at the ends, but as they are seldom used by more than one person the inconvenience is materially lessened.

In this kind of table, as in all others, we have to consider the supports, the frame, and the top; but here, however, the frame is not so conspicuous a member of the structure as in the square table, and holds a more subordinate position. The end elevation of this table is shown in Fig. 10 and the front elevation in Fig. 9. To make the saltire-shaped supports, four pieces of good straight-grained red deal must be selected, two for each end, each piece being about 3 ft. long and 6 in. wide. This will leave room for giving to the boards the curves or variations of outline necessary to give an ornamental appearance to the legs. As the pieces are

to be framed together by halving them into one another at the part where they cross, the wood used for the legs should not be less than 1 in. in thickness when planed down; and if 1½ in. stuff be used it will add greatly to the stability of the table. Across the upper part of the cross formed by the legs, a slip or ledge of wood ¾ in. thick must be screwed; this is the only part that answers to the framing of the square table, and serves to support the ends. When the cross-pieces have been halved together and the ledges securely screwed on, the supports for the ends of the table-board or top are complete, and it only remains to connect them.

The top of the table must be formed in the usual way of ¾ in. boards glued up together, and held in clamps till dry, or connected by tongue and grooves as already explained (see p. 113). To give strength to the table-top, ledges should be screwed across the boards on the under-surface. The supports for the ends must be connected by a rail, the ends of which are cut into the form of a tenon, and passed through the part of the support where the cross-pieces are halved together. A hole is made in each projection, and through the hole a wooden pin is given, locking the supports in an upright position against the shoulders of the rail at either end. To afford a better support to the table-top, and additional strength to the supports, another narrower rail is passed through the ledges and secured in a similar way by pins inside and out. This rail should be placed in such a position that the ledges may bear tightly upon it. Even greater firmness and stability may be given to the table by making the rail as deep as the end ledges and notching it at the top to receive these ledges, which may be concealed by a slip of wood about 1 in. in depth screwed to the under part of the table on each side. The table-top should be screwed down securely to the broad edges at either end. When this is done the whole structure will be found to be as secure and rigid as any table made in the ordinary way. The centre rail joining the cross-pieces, forming the legs like the cross-pieces themselves, may be shaped to suit the fancy of the maker. An infinite variety of forms will suggest themselves, but care should be taken to let the pieces of wood, out of which these parts of the table are made, be deep enough to admit of being cut into without impairing the stability of the table.

Stools.—The structure of the lower part of the Windsor chair to which reference has already been made, is identical in almost

every respect with that of the stool, the only difference being that when the legs of the stool are short there is less need to connect them with cross-rails. Generally, it may be laid down as a rule that when the height of the stool is not more than 12 in. the legs need not be connected by cross-rails, but when the stool is above this height or even, as in the case of music-stools, above chair height, the structure should be strengthened in this way. If the legs are short, as in the case of a milking-stool, they will of course be stiffer, and provided they are properly fixed, will not be driven outwards when a heavy body is placed on the top. In fixing the legs in a stool to be used either as a temporary garden seat or a stand for a plant, the holes should be bored with a stock and bit quite through the piece of wood which forms the top. The ends of the legs should then be sawn across to the depth of 1 in. or 1½ in. and very slightly tapered to the same extent. When they have been driven into the holes as far as they will go, wedges of hard wood should be inserted in the saw-cuts and hammered in as far as possible. Any part which afterwards projects beyond the level of the seat must then be neatly sawn off (Pl. I, Fig. 8).

The stools which the amateur will be chiefly called on to make for use within doors will be fender stools, and ottoman or box stools. These come more within the province of the cabinet-maker and upholsterer than that of the ordinary carpenter and joiner; but it will be useful for the amateur woodworker to know how to make them, in order to mount any piece of work, in the form of either Berlin-wool work, or braided cloth or velvet, that may have been executed for this purpose.

A **fender stool** may be of the box or ottoman form, that is to say, constructed with top, sides, and ends of wood; but it is sufficient to have a piece of board only for the top, with three or four supports beneath it that will bring the top of the stool just level with the top of the front of the fender. In making such a stool solid supports are far better than legs. There should, of course, be a support at each end; it will depend entirely on the length of the stool whether there should be one more support in the centre of the board that forms the top, or two having the same distance between them as there is between each of these and the end support next to it. That is to say, if the stool be 4 ft. 6 in. long, and the supports be 1½ in. thick, and the ends of the stool overhang the supports for 1½ in., the clear distance between each support, there being four of them, will be one-third

of 4 ft. 6 in. less 9 in., or one-third of 3 ft. 9 in., which is 1 ft. 3 in. In the fender stool, the ends and centre pieces used as supports should be mortised into the board that forms the top of the stool. It will add to the general appearance of the stool if the *outer edges* of all the supports and the *outer faces* of the end supports be carved. The upholstering of this and similar articles of furniture are dealt with in a later chapter (see p. 304).

Ottoman or box stools are generally square in form. The sides are of wood, stained, if of deal, and French polished. The construction is simple enough. Four pieces of wood that form the sides are dove-tailed together in just the same manner as the sides of a box. These pieces are about 3 in. wide and from 12 in. to 15 in. long. The top is boarded over flush with the frame; but a broad ledge is nailed round the bottom, leaving the interior of the stool open. The breadth of this ledge serves all the better for attaching the balls or bosses that form the feet of the stool, which are put on with screws. The work is strained over the top, which is stuffed in the manner to be described later. If the work covers the top only, and not the sides, it is desirable to cover the edge with a rounded moulding. Another moulding of different form is placed in the angle formed by the sides of the frame, and the ledge below. This does away with the abrupt appearance that the angle would present if left unfilled. A good plan for making ottomans of this kind is to strain the cloth or material that forms the top, whatever it may be, on a separate piece of wood or frame of the same size as the top of the box, or just so much less than the thickness of the work when nailed on, which will bring it to exactly the same size. The moulding should be raised slightly above the upper edge of the frame, or rather top of the box, so that the board with the work attached to it may be dropped into the recess. When made in this way the piece of wood on which the work is strained must be screwed down to the top of the box with a few screws driven in upwards from the inside.

It will be at once manifest to the amateur that it is impossible within the limits of this work to touch on every kind of article that may be comprised within the general and comprehensive term, "household furniture." If he can use his tools well enough to make a small and strong kitchen table, and thoroughly understands the principles of its construction, he can make, as we have said, any kind of table or article that acts as a table, in furnishing a stand or support for other things, as, for example, a washstand,

so that there will be no necessity to say anything about furniture of this kind here. Cupboards, chests of drawers, etc., and their component parts, such as door and drawers, will be dealt with later.

Sofa or Couch.—The amateur, in all probability, will never seek to make such a sofa or couch as is sold nowadays with suites of furniture in mahogany or walnut, for dining-rooms and drawing-rooms. If, however, he has purchased an old sofa or couch and seeks to repair it, the instructions already given and the skill which he has acquired in the general work of carpentry and joinery, will enable him, after some study of the construction of the article, to do so.

To those, however, who desire to construct for themselves a strong plain couch which, while serving its ordinary purpose, may be used in time of need as an invalid couch, the following description of the manner in which such an article can be made may be useful.

The first thing to be done is to make a strong frame, 6 ft. 6 in. long and 2 ft. 6 in. wide. For this purpose two pieces of sound red deal, 6 ft. 6 in. long, about 2 in. or 2½ in. thick and 3 in. wide, and two other pieces of the same width and thickness and 2 ft. 6 in. long should be selected. When all have been planed up truly square, the shorter rails should be mortised into the ends of the longer rails so as to form a strong, solid and substantial frame. Four square blocks must be screwed to the frame, pierced with threaded holes into which the ends of the legs are screwed. These legs, supposing the block to be 2 in. thick, may be 12 in. long exclusive of the castor attached to the end of each leg; they may be bought ready made of the turner or upholsterer; or, if the amateur has not a lathe in which he can turn them for himself, he may get them turned by any one in his immediate neighbourhood who executes work of this description. A long slip just 1 in. square, or a little less, is nailed or screwed along the outside edge of the sides of the frame, and, in the framing itself for the distance of about 12 in. from each end, notches are cut in order to form a kind of rack for a purpose that will appear presently. This completes the frame of the couch.

The next thing to be done is to make three panels, two 18 in. in length, and one about 3 ft. 9 in. long, all of them being 2 ft. 6 in. wide at the top, but rebated on the under side so as to fit into the rebate formed in the sides of the frame by nailing on the slips to the sides of the frame as previously described. The framing and the top of the panel will thus be flush throughout, and

the ledges in the outer part of the framing will fit over the slips on the sides of the frame of the couch. When the panels are lying flat on the frame, the two short panels cover one half of the frame and the long panel the other half. The short panel at one end does not project beyond the frame, but the long panel being 3 in. longer than half the length of the frame, projects to the same distance beyond it. The panels must now be connected by hinges, those which connect the short panels being screwed on below, while those which connect the middle panel and the long panel are screwed on above, so that the short panels may be raised upwards in the form of the letter V reversed, thus Λ, while the long panel may be lifted so as to form a V with the middle panel. When the three panels are placed in this position, the bottom of the short end panel is kept in place by the rack at the end of the frame of the couch, while the long panel is similarly sustained by a frame bolted to the sides of the panel-framing about 2 ft. from the end, in the same way as the back support of an ordinary deck-chair. Thick cushions rather longer than the panels are made to suit each and, to retain the cushion in position, on the slope of the bottom short panel a ledge is fixed. The construction of the couch, when used for ordinary purposes, is such as will admit of a person lying full length or, when required for use as an invalid couch, it may be adapted, as described, to a recumbent position. When the panels are laid perfectly flat, a head board may be fixed across the upper end and a bolster and pillow used as in an ordinary bedstead.

Instead of wooden panels, sacking or webbing may be stretched over the frames, or iron laths, similar to those used with iron bedsteads may be interlaced and screwed down to the framing with strong round-headed screws. When the frame is nicely stained and varnished and the cushions covered with chintz or cretonne, the whole makes a piece of furniture which is by no means unsightly, and though it may be somewhat stiff and formal in appearance, such a defect is amply compensated for by its comfort and utility.

If the amateur can make a couch as described above he will find little difficulty in making an old-fashioned sofa with upright ends and back, or a couch with one upright end and a back about two-thirds of its length. Both sofa and couch may be made with a frame as shown above to which the ends and back must be attached; or, in the case of the sofa, ends may be made something like the back of the easy-chair to which reference has been previously made (p. 232).

Simple Folding Bedstead.—A comfortable folding bedstead for a child or for use as a spare bed which can be put up anywhere in a few minutes as occasion may require, may be easily made in the following manner.

Get two pieces of deal, about 3 in. wide and about 2½ in. thick, to form the sides of the bed. Other pieces of stuff—hard wood will be found better than deal—about 2 in. wide and 1½ in. thick, or even a little stouter, must be taken for the legs, which will have to be mortised into the rails that form the sides. These legs must be cut at an angle, so that they may stand flat on the floor when the bed is opened out, and one corner of the long side-rails must be planed off to the same angle in order to produce a horizontal surface. Care must be taken to cut the mortises in the rails in such a manner that the outside of the legs attached to one rail may come against the inside of those in the other rail. It is precisely on this principle that the stand for a butler's tray is made; the chief points of difference between a butler's tray-stand and an X bedstead being, that the legs of the former are longer than those of the latter, while the rails on which the tray rests are shorter; that each pair of legs of the butler's tray-stand is connected near the bottom by transverse rails to strengthen them, while those of the bedstead are not; and, lastly, that the sacking from rail to rail in the bedstead is replaced by three pieces of narrow but strong webbing in the tray-stand.

The legs are fastened together at the point where each pair cross one another by a bolt and nut, the bolt being put through from the outside and the nut therefore hidden from view on the inside. A piece of strong sacking is then nailed across the bedstead, from rail to rail; it should extend the whole length of the rails. The sack-cloth will prevent the legs from opening beyond a certain extent, and, when the bed is in use, affords a comfortable and elastic support. The head is formed by a piece of board, with pieces of wood or iron screwed to the back with pins at the bottom which fit into holes, bored into the side-rails for their reception. The head is put on after the bed is opened to its fullest extent, and prevents the bed from collapsing or shutting up under the pressure of the weight placed on the sacking.

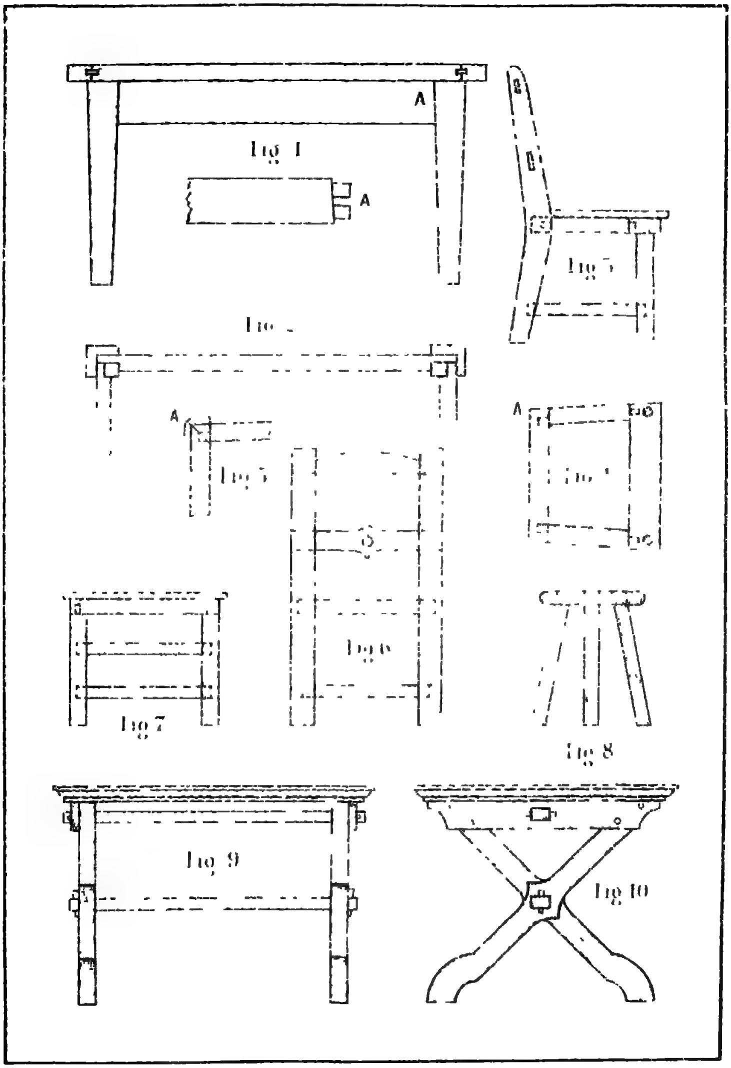
Flower-stands and Stages.—Flower-stands and flower-stages will in all probability frequently command the attention of the amateur; it will be desirable, therefore, to point out how these articles may be made, and to include in the information given

on this point some directions for making hanging-baskets of a simple character for decorative purposes, both within doors and in the open air.

Let us first take the stage on which pots containing flowers may be placed. Small stages of this kind are very useful in gardens of limited extent. They may be made square or semicircular in form; that is to say, in the shape of simple straight shelves rising one above the other, or in tiers of shelves returned, or in tiers of semicircles. In a garden where two straight paths intersect, a circular stage filled with flowers supplies a means of ornamentation that is both beautiful and appropriate.

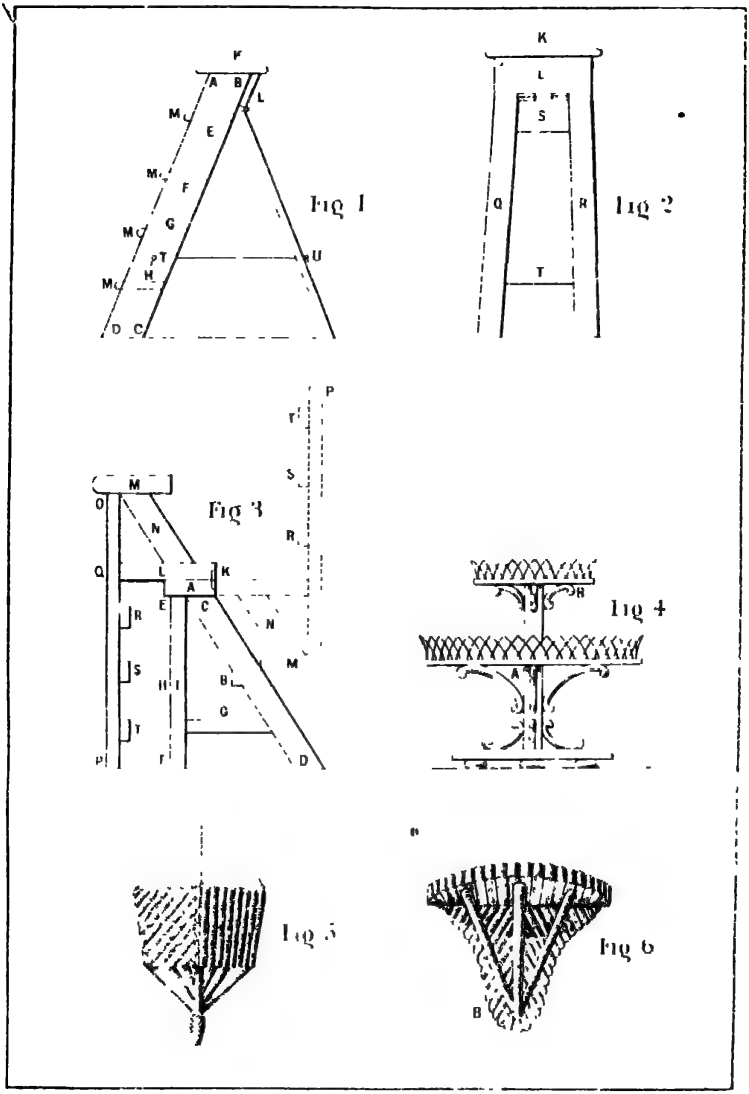
The simple stage of three, four, or more straight shelves rising one above another is easily made. The great object is to keep each shelf clear of the one immediately above it, and to exhibit the flowers to the best advantage, causing them to conceal the stage or frame on which they stand as much as possible. To explain what is meant, let us suppose that the stage is intended for plants that range about 12 in. in height, and are contained in pots 6 in. high. Now the top of the plants in the lower row should be on a level with the rims of the pots in the row just above it; and consequently, as each plant and pot are together 18 in. in height, the distance between the shelves should be 12 in. This general rule will be sufficient to guide the amateur in making stages for special purposes. Thus for example, for staging auriculas the distance between the shelves need not be so great as for pelargoniums. In a stage for a greenhouse, this rule cannot be carried out owing to the variety of plants that are put on the stage. For greenhouse stages, 9 in. shelves, made of rails and not of single boards, at a height of about 15 in. one above another will generally be found suitable and convenient. For large plants the shelves may be wider. A stage of this description may be put together in the course of a very few hours. All that is necessary is to screw some uprights and transverse pieces together at right angles to each other, so as to form the two ends. If the stage be a long one, intermediate supports of the same construction must be introduced. The supports are then connected by rails, which form the shelves on which the pots stand. Horizontal rails should be placed along the back of the structure, and additional strength should be given to the frame by diagonal braces at the back, and by braces in front of each step, if the frame be a long one. A neater and lighter appearance will be given to the frame if the supports are made of 1½ in. stuff halved into each other; but this will take time, and if the amateur can

Plate I. CONSTRUCTIONAL WOODWORK.



1. Kitchen table, elevation. 2. Kitchen table, plan of framing. 3. Wooden chair, side elevation. 4. Panel. 5. Wooden door, frame work. [illegible] 6. Wooden chair, back. 7. Wooden form, front. 8. Milking stool. 9. Writing table, front elevation. 10. Writing table, end elevation.

Plate J. CONSTRUCTIONAL WOODWORK.



1 and 2, House steps. 3, Combined house-steps and chair. 4, Flower stand. 5, Hanging basket. 6, Bracket flower stand.

give time to the construction of his frame, he may as well make it more ornamental in character.

To do this, a broad board must first be taken, and cut so as to present the form of brackets on which the rails that form the shelves are laid. To support the diagonal bracket-board an upright is mortised into it at the back, and the diagonal board and upright are further connected by a transverse rail. To keep the supports together and to strengthen the frame, rails may be placed parallel to the shelves. Square, semicircular and circular stages assume a pyramidal form, and provision must be made for the return of the shelves round the sides. The supports must be made in the same way, but, on consideration, it is clear that they must be arranged as radiating from a common central and vertical line. A convenient length for a rectangular stand will be twice the width or depth, but in no case should it be less. When the length is more than twice the width there must be two supports instead of one between the ends. The rails or boards of which the shelves are made are mitred on the brackets proceeding from the supports in the rectangular frame, but in the semicircular frame, if small, the boards may be cut in quadrants, or if large, extended merely from bracket to bracket as in the rectangular form.

Flower-stands admit of an almost endless variety in their construction. Generally, it may be said that they consist of a central support or stand, after the manner of the pillar of a round table, which is made to support two or three stages or shelves on which plants are placed. Stands of this description must of course be suited to the circumstances of the position which they are to occupy. For example, to stand before an ordinary window, a long and comparatively narrow form will be most suitable ; but for a bay-window a circular stand will be far more appropriate. It may be serviceable to the amateur to give particulars of both of these flower-stands.

A suitable stand for an ordinary window is shown in elevation in Pl I, Fig. 4. A central pillar springs from a bold base supported on four feet, and above each foot is a bracket which may be let into the pillar as shown in the illustration. From the top of each bracket springs a support which, with others and the central pillar, helps to sustain the flat board A, which forms the lower shelf for the reception of the plants. The pillar passes through this lower shelf and is mortised into the upper shelf B, which is partly sustained by supports similar to those below and springing like them from the central pillar. The boards may be furnished with an edging of wire-work as shown. This

is easily formed by boring holes in the boards near the edges and fixing in loops of wire bent to the required shape. The loops may be bound together at the points of intersection with very fine wire, which will serve to strengthen the edging. The shelf itself may be either oblong or oval in shape. In making a stand of this kind the top shelf B should be of sufficient length to take three pots of a fair size, and the lower shelf A should be at least three times the width of B.

For a bay-window a suitable and pretty stand may be made in a somewhat similar manner. A central pillar rises from a base ornamented with brackets, which may be made as elaborate as desired by fret-sawing.

From the edge of the shelves rises an upright edge formed of a bold moulded board, or board enriched with mouldings, carried high enough to conceal the pots. To suit the mode of construction the shelving should be octagonal in shape, and the top be just large enough to contain a single pot. The cases thus formed should be lined with pans or trays of zinc, there being two trays for the lower part so that they may be conveniently lifted out when necessary. The tray will catch and retain any surplus water that may drain away from the pots when the flowers are watered. The spaces between the pots may be packed with moss, which will keep everything in the stand fresh and cool, and so render it needless to water the plants too frequently. The stand should be stained and varnished, the rich brown tint thus obtained presenting a marked contrast to the various greens of the foliage of the plants and the brilliant hues of the blossoms.

Hanging-baskets.—Hanging-baskets form a pleasing decoration for greenhouses, bay-windows, halls, passages, etc., and any places in which they can be conveniently suspended. For walls they may be made in the same form, the mode of suspension being adapted to the position. For example, if made in a rectangular or semi-octagonal form, the part that touches the wall may be made higher than the other sides and a hole made in it so as to hang the box on a nail or hook driven into the wall for that purpose. Fig 5 (Pl. J) affords a pretty example of a hanging basket. To make this, five pieces of wood must be cut out and nailed together to form the bottom and sides, and the sides, if not the bottom, must then be covered with pieces of hazel, or other straight sticks, sawn or split in halves and coated with varnish or boiled oil. The pendant is formed of pieces of stick strung on wire, the whole terminating in a fir cone or some rustic ornament.

A wire attached to each corner forms the means of suspension from the roof. Fig. 6 is introduced to show how a bracket may be treated in a similar manner. A very effective square or hexagonal basket may be made by cutting some hazel rods or other straight sticks into equal lengths, and stringing them on wire. For the bottom of such a basket a piece of wood of the form intended for the basket—whether triangular, square or hexagonal, it matters little except that numbers divisible by two are more convenient for the number of sides of these baskets—is taken, and two pieces of wire, which have been previously passed through two of the sticks that have been cut, are passed through the holes in the corners of the bottom board, the ends pointing upwards. On these wires sticks are strung in alternation until the basket has been carried high enough. The ends of the wires must be looped by the aid of a pair of pliers, and passed over an S hook, by which the whole may be suspended. The uses of such a basket are numerous, and will suggest themselves to the amateur. A wall-basket or pocket may be made, as it was said, by forming half a hexagonal or octagonal basket, and suspending it on a nail after covering the exterior with cleft sticks, after the manner shown in Figs. 5 and 6, or with virgin cork. Any pretty hanging plant looks well in such a basket.

Closely akin to the subject which we have been considering, though by no means identical with it, is the Wardian case, or glazed window-box, which in some situations takes with advantage the place of the window-box or tray. This form of box is supported on the window-ledge and secured to the outer board of the window-frame in which the sashes are hung. A sound piece of wood about 18 in. in width and equal in length to the distance between the reveals of the window on either side must be taken for the bottom. The sides and front of the box consist of three frames entirely filled with glass or with a wooden panel at the bottom and the rest glass. The bottom should be firmly screwed to the sides which rest upon it; or, if preferred, it may be dovetailed into them. The front should be constructed so as to rest upon the bottom and against the edges of the sides to which it must be secured with screws. If desired, the front may be made in two parts, the upper part being hung to the top of the case, like the light of a greenhouse, to open outwards and admit air, or a single pane may be made to open outwards. The top rests on the front and sides and should be so constructed as to abut as closely as possible against the lower rail of the upper sash,

to which, if it can always remain closed, a strip of india-rubber or similar substance may be fastened so as to lap over the edge of the top next the sash and prevent the entrance of rain. Access to the window-box is obtained by opening the lower sash. So much has now been said on the mode of putting such a structure together, that it is unnecessary to go into minute details which the amateur already understands and can put into practice for himself.

CHAPTER VIII

WINDOWS, DOORS AND GATES

Windows.—As windows form an essential, though a separate and distinct, part of house-building, as far as it may be practised by the amateur in the construction of sheds, greenhouses, etc., and as doors also, whether for cupboards or any small enclosed space, or as the means of entrance to rooms or outbuildings of any kind, are also pieces of carpentry that are complete in themselves, a short chapter may be devoted here to their consideration. It is all the more necessary and convenient to take windows and doors separately, because it is impossible to treat of the construction of a cupboard or wardrobe without mentioning the door which is so essential a part of each; and, when the structure of various kinds of doors has been described, a mere allusion to them is all that will be necessary when speaking of those various structures and articles of furniture of which they form a part.

Windows may be broadly classified as being of two kinds—casement windows and sash windows. Casement windows are hung on hinges like doors, or made to move on pivots inserted in the centre of the sides of the window-frame. Sash windows, on the contrary, slide up and down, being raised and lowered and retained in any desired position—whether slightly open or opened to the utmost extent—by counterbalances in the form of iron weights attached to the window-frame by means of sash cords that work over pulleys set in the frame in which the sashes work.

For outbuildings of all sorts, whether sheds or constructions used as workshops, greenhouses, or summerhouses, casement windows will be found most convenient and most suitable to the purposes of the amateur. From the description of one casement window and the method of hanging it, the amateur will easily see how all windows of this formation, whether large or small, may be made and hung. In all kinds of windows, as glass is

now so cheap, the amateur is counselled to make them without cross-bars, resorting to these only when the window is of great size, and even then restricting himself, if possible, to vertical bars, which will reduce the size of the panes sufficiently for all purposes and positions with which the amateur may have to deal.

Casement Window.—A casement window may be described as a movable frame, fastened by hinges to and within another frame fixed in position. In brickwork this fixed frame is placed in position, and the bricks built up around and over it; but when the structure is made entirely of wood, advantage may be taken of the vertical timbers of which the framework of the building is made to hang the casements to these, and so save the cost and trouble of making a special frame to receive them.

Let us, first, take the case of a simple casement window and frame inserted in a brick wall. Of course, here, as in other descriptions of articles to be made by the amateur carpenter, dimensions are altogether neglected, for these are relative and subordinate to the position and extent of opening to be filled by the window, and must be determined accordingly. It will be sufficient to say in most cases timber 3 in. in width and from 2 in. to 3 in. in thickness will be sufficient for the frame and from $1\frac{1}{2}$ in. square to 2 in. by $1\frac{1}{2}$ in. or 2 in. square for the frame in which the glass is to be inserted. The dimensions having been settled and a working drawing having been made, the amateur may proceed to the construction of the window and the frame that encloses it.

The technical terms for the various parts of the casement frame are as follows:—the top part, the head; the lower, the sill; and the sides, the jambs. In double casement windows, the piece dividing the opening vertically is known as the mullion. These parts form the casement frame, into which the sash is fitted. This frame differs from the *cased* frame used for sliding sashes in being "wrought solid," that is, the parts are all made in solid wood and not of boards so as to form hollow casings. The parts of the sash are the stiles, which form the sides; the bottom rail; and the top rail. When sashes are divided for two or more panes of glass, the bars used for this purpose are termed either vertical or cross bars according to their direction in the frame. This information may be of use to the amateur who desires to make his window frames from the machine-wrought stuff which he may obtain from one of the large wood-working firms dealing in such material.

In making the frame the first thing to be done is to cut off the requisite lengths, the horizontal pieces or head and the vertical pieces or jambs and then mortise the jambs into the head leaving the ends of the horizontal pieces projecting beyond the outside surfaces of the jambs. This is done for two reasons, first to give greater strength to the mortise and tenon joint which would be weakened if the projecting pieces were cut off flush with the outside surfaces and secondly, to enable the frame to be fixed with greater security in the brickwork; the projections enter the brickwork and are held above and below if not on all sides by the bricks somewhat after the manner of a mortise and tenon joint. When the uprights have been mortised into the horizontal pieces and secured by means of pins, the frame is complete and ready to be put in its place.

The frame for the glass is made in much the same manner, but a rebate must be cut in the pieces of which the frame is composed for the reception of the glass. In the case of the inner frame, the horizontal pieces are mortised into the uprights instead of the uprights being mortised into the horizontal pieces as in the outer or fixed frame. In small windows of this kind no cross-bars or even vertical bars are required; if, however, the window be of some size, and the chances of breakage be above the average, it may be desirable to reduce the size of the panes by inserting vertical bars or even crossbars. The window-frame having been primed and glazed, it will be necessary to fix it in position. We will assume at first that the window is to open inwards. In this case the inner frame must be inserted in the outer frame, and the measurements marked round the inner surface of the outer frame with a pencil. Stops must then be nailed round the inner surface of the outer frame, the inside of the stop in every case just touching the pencil mark. The window must then be attached to the frame by a pair of hinges, 2½ in. or 3 in., common iron butts being the most suitable. A knob is usually attached to the inside of the window, for the purpose of pulling the window open. The window is fastened and kept from being forced inwards by wind or any other pressure by an iron or brass button, screwed to the fixed frame so as to be turned over or away from the window at pleasure.

It will be at once apparent to the amateur that if he wishes the window to open outwards the stops must be put inside instead of out, and the window brought flush with the *outside* of the fixed frame instead of the inside. The hinges will also be turned

outside instead of inside. In fact, the window and window-frame are precisely the same as described above, only that which was the inside in the first case is the outside in the second case. When the window opens outward, the button which is screwed on inside must be fixed to the window instead of the frame, and be turned at pleasure over or away from the stops. If desired, a bolt may be fixed to the frame instead of the button.

It may be convenient for some reason or another to hinge the window to the top or bottom of the frame instead of either of the sides. In this case the mode of procedure is precisely the same; but when the hinges are attached to the bottom of the frame, it is necessary to prevent the window from opening beyond a certain extent by means of a small piece of iron or brass chain attached at one end to the frame, and at the other end to the window, by small staples. If the hinges are attached to the top of the window and top-rail of the frame, the window must be kept open by means of a rack or stay-hook.

The rack is an iron bar pierced with holes that fit over a peg which is screwed to the frame, the rack itself being attached to the window by means of an iron plate fitted with a pin on which the rack moves to right or left as may be necessary. The stay hook, on the contrary, is fixed to the frame by means of a staple, and the hooked end drops into an eye which is screwed into the frame. These racks and stay hooks may be purchased at the ironmongers very cheaply. There is another kind of rack consisting of two arms moving on a pivot, by which they are joined together in the middle and fastened at the other end with pins to plates which are screwed one to the window and the other to the frame. Some of these racks are fitted in the centre with a grooved joint, technically called a "knuckle-joint." Thus, the raised part of one arm is pressed into the grooved part of the other arm by means of a thumb-screw and the extent of opening may be regulated at pleasure, the arms being held in position by the action of the thumb-screw. These racks are more suitable for attachment to the *sides* of windows when the windows are hinged at top or bottom. They should never be attached to the part of the frame *opposite* the hinges, for as this moves in an arc of a circle, the two-armed rack would not act properly. For windows hinged at the top and opening outwards the stay hook and the bar rack are the most suitable. For greenhouse windows an arc of iron, pierced at intervals with holes, is often used. This arc moves within an iron casing the sides of which are pierced with holes, and when the window has been opened to the desired

extent a pin is thrust through the holes to prevent further movement outwards or inwards.

Whilst dealing with greenhouse windows, it may be useful to state that instead of putting stops round the inside of the frame to prevent them from being pushed inwards, the same result may be obtained by nailing or screwing a slip of wood all round the window on the outside projecting about ¾ in. beyond it. When the window is closed this slip acts as a stop to keep it from further progress inwards. It also tends to prevent the entry of rain between the window and frame, which is often the cause of the wood swelling so that it is difficult to open or shut the window.

The above description of the casement window and the method of hanging it by hinges to its frame holds good, as far as the making and fixing of the window itself is concerned, to a window attached to the framing of a wooden building as well as to one fastened to a frame built into brickwork. All that is necessary here is to see what provision should be made for finishing a window such as we have been considering, when the framing of the building is adapted to furnish the frame of the window.

Double Casement Windows.—The construction of a double window is similar to that of the single window described above, but the opening is divided by fixing a mullion or vertical timber down the middle, mortising it into the top rail and the sill. The windows on either side of this upright are hinged to the jambs. This kind of window will be found particularly useful in the construction of a weather-boarded or framed house with plastered walls. In this case three of the vertical timbers forming the framework of the house may be utilized in making the casement frame, the two outside timbers serving as jambs and the middle timber as the mullion. Having determined the length of the window and the thickness of the sill, it will be necessary to halve two pieces of wood into the uprights to form the heads of the frame and two more below to form a bed for the sill, and suitable means of attachment for the boards or plaster, as the case may be, that are put up immediately under the window-sill. When these transverse pieces have been fixed in their places, the next step is to put on the sill, which should be halved into the uprights at each end and in the centre, and sloped slightly on the upper and outer ledge, so that no rain may effect a lodgment on it, but may trickle off to the outer edge. When this has been nailed securely in its place, two rectangular openings are formed, round which a casing should be nailed, in each

opening. This casing may vary from ⅝ in. to 1 in. in thickness, and should project beyond the outer face of the uprights and other parts of the framework sufficiently to allow the weather boarding or plaster with which the framework is covered in to drop within them to the extent of at least half an inch. There is no absolute necessity to continue the casing at the bottom, but it makes a neater and more symmetrical piece of work when this is done. The casing takes the place of the frame in which the window is placed when set in brickwork and to this the stops must be nailed and the windows hung. A piece of wood must be fixed between the casings and nailed to the mullion to give a proper finish to the window, and take away from the depth between the casings on either side of it; and it will look all the better if the casing is made to appear as if it were continued along the whole length of the double window by nailing two slips of wood between the top and bottom parts. It is practicable to use the uprights and horizontal pieces as the frame of the window without the intervention of any casing; but in this case that which is now considered to be casing will be stops, and narrow pieces of wood must be nailed to the uprights, and the cross-pieces to serve as projections, within which the ends of the weather-boards or the slabs may be dropped. Of course these projecting pieces must be nailed on flush with the inner edges of the openings.

In the case of a window in a frame set in brickwork, or a concrete wall, a finish may be given to the frame and window by nailing a neat moulding around the frame both on its inner and outer surface close to the outer edge of the frame.

Sash-Windows.—With regard to sash windows, it is unlikely that the amateur will ever attempt to make a complete window with the sash divided into small openings. In recent years the tendency even in professional work has been to avoid this as far as possible. In many cases, the sash at top and bottom consists of a frame in which one large pane is set or at the utmost the space is divided into two parts by one vertical bar or into four parts by a vertical bar and a horizontal bar crossing each other at right angles.

When a frame of this kind is made, sash bars moulded to the desired form by machinery are used. The making of the frame is easy enough as far as construction goes, but the whole work throughout its various component pieces requires to be very neatly and accurately framed together. The transverse pieces at top and bottom

must be mortised into the upright pieces or the sides ; the upright bars in their turn must be mortised into the transverse pieces of the frame, and the cross-bars must in their turn be mortised into the sides and vertical bars. When every part is ready, the pieces must be glued up, and put together with a few strokes of the mallet, the tenons being tightly fastened into the mortise holes by wedges. The bottom rail of the lower sash is made from two to three times as broad as the upper rail. The bottom rail of the upper sash, instead of being planed flush with the rest of the frame, is made in a sloping direction inside, the width of the lower part being the greatest. In the same manner the outer part of the upper rail of the lower sash is made to slant outwards and upwards, so that the upper part of the rail is the thickest.

It is far more useful for the amateur to understand the construction of the cased sash-frame than that of the sash itself, for he may be called on, now and then, to repair a broken sash-line, and, unless he knows how the sash-frame is made, he will find this no easy task. The construction being known, the mode of going to work in order to substitute a new sashline for the broken one is easy enough.

The frame into which the sashes are fitted is a somewhat complicated arrangement, or at least it will appear so to the amateur. Between the solid sill at the bottom of the window, which rests on the stone ledge or sill, and the thick piece of wood which forms the lintel across the top of the window, two box-shaped sides are fixed, to which are attached the beads or guides which keep the sashes in their places, and in which are inserted the pulleys over which run the cords to which the weights are attached, the weights being out of view in the casing. In Pl. K, Fig. 1, this arrangement is explained ; J is the head or lintel at the top of the sash-frame and K the sill at the bottom ; H and I are upright pieces of wood forming the fronts of the casings fixed on each side of the window, the sides being cut away except near the bottom of the window, so as to show the weights. These weights, WW, work over the pulleys PP, which are inserted in the fronts of the side-boxes. The weights shown in the illustration are those attached to the bottom sash, which is closed. When the weights are near the top of the frame the sash is closed ; when the sash is raised the weights descend and keep the sash in any position to which it may be lifted and allowing it to be raised until the rail is nearly in contact with the lintel. When in course of time the sash line is worn and breaks, the weight falls to the bottom of the frame. A broken sash-line should always

be replaced without delay and generally it will be well to take the opportunity of renewing all the sash lines of the window since when one breaks the others are more or less "perished." A window left with only one cord is always a source of danger to persons opening or closing it, as if that cord breaks the sash is left quite without support and falls heavily, the cross-bars striking the hands and wedging them against the lower framework. When replacing a broken sash cord, care should be taken to use only the best cord. This is made of flax and plaited; twisted cord is useless, for the way in which it is made causes the weight suspended by it to turn round so that in time it is untwisted and weakened; it will also tighten in wet weather and stretch in dry weather, and in either case becomes useless for its purpose.

Supposing the cord which attaches the weight to the right-hand side of the sash is broken, the amateur must first proceed to remove the bead on the right-hand side of the window, lifting it out of its place with a chisel. This will not be very difficult, as it is merely bradded in its place by thin nails; care should be taken not to injure the paint more than can be helped. The bead being withdrawn, the sash may be easily slipped out of its place, and the side exposed to view, in the upper part of which is a shallow groove just deep enough to hold the sash-cord, and in which the end of the broken cord will be found to be nailed by two or three clout nails, or nails with flat, round heads. The nails must be pulled out and the cord removed. A close inspection of the side of frame will show the amateur where the "pocket" is. This is a long slip of wood nearly as broad as the groove in which the sash moves; it is fitted tightly into a long slot cut for its reception, but may be easily lifted out with a chisel. The top of the weight will then be visible, this must be taken out and the cord removed. The next point is how to get in the new cord. To effect this a piece of twine must be attached to one end of the new piece of sash cord, and a small piece of chain to the twine. The chain must then be passed over the pulley into the frame, dragging the twine with it, and by this the sash line may be drawn into the frame and brought out at the bottom. The cord must then be knotted to the weight and the weight returned to its place, the piece of wood which has been removed being carefully replaced in its slot. It now remains to nail the cord to the frame, and to determine the proper length at which it must be cut off; the weight must be pulled up nearly to the top, and

the cord cut off about 8 in. or 9 in. below the lower rail of the top sash, the end must then be laid into the groove and attached to the frame of the sash with nails. The sash may then be replaced and the bead restored to its original position. When it is necessary to take out the top sash, the bead and the lower sash must first be removed, after which the parting-bead must be slipped out, which is a matter of no difficulty, as the bead is merely dropped into a groove ploughed in the frame for its reception.

Doors.—In considering doors we may regard them generally as falling into two classes—ledge doors and framed doors.

In Pl. K, Fig. 2, is shown the ordinary form of **ledge door.** In order to clearly show the construction and the manner in which the door is attached by hinges to the side post or frame, the elevation given is that of the door as seen from the inside.

If the door is to be fitted to a framed wooden building, provision must be made to adapt part of the framing as the jambs or side-posts and lintel; but if the door is to be inserted in a brick wall, or a wall of any other material, a frame must be made for its reception. In either case the principles of construction are the same, and as the amateur does not now require to be told how to make a frame for a door, we will take it for granted that the door is intended for some outbuilding that he has built of wood, for a workshop, or any other purpose. In this case A and B are two uprights, portions of the framing, mortised into the horizontal piece of wood D at the bottom, which serves as the sill of the door. At a suitable height, say 6 ft. in the clear above the sill, a piece of quartering, C, is mortised, or notched, into the uprights, as may be most convenient. Mortising is strongest and neatest, and as the insertion of C should be provided for when the framing is in course of construction there will be no difficulty in putting in the lintel in this manner. If the frame is made separately for insertion in a wall, the ends of the sill and lintel should project beyond the uprights, as shown at E and F.

With regard to the door itself, supposing the width between the uprights to be 2 ft 2 in., 4 pieces of match-boarding, ⅝ in. or ¾ in. thick and 7 in. wide, allowing for the width of the tonguing and grooving, will be sufficient for the vertical boards shown at K, L, M. These boards, it need scarcely be said, extend from top to bottom. Two ledges about 6 in. wide and ⅞ in. thick, are then placed horizontally, as shown in the

figure; and to these the boards K, L, and M are nailed with *clasp nails*, which should be used because the ends can be turned and clenched in the ledges. These nails are driven in from the outside. When the door is a light one, two ledges are sufficient, but when it is large and heavy, it is better to use three ledges, one in the centre, and one near the top, and a third near the bottom of the door. To strengthen the door shallow notches are cut in the ledges at P and Q, to receive the corners of the brace R, to which the boards that form the door are also nailed and clenched. When three ledges are used two braces are required; these braces must be inserted in precisely the same manner as the brace shown in Fig. 2.

To fix the door, it must, when fitted nicely into its opening, be held in position between the jambs A and B so that the outer surface of the ledges is flush with the inner surface of the jambs. Pencil-marks must then be made down the faces of the jambs to show how far the outer surface of the door projects. The door must then be removed and stops nailed to the faces of the jambs and the under-surface of the lintel. The door must then be replaced and two thin pieces of wood inserted between the sill and the bottom of the door so as to slightly raise it and prevent it from dragging on the sill when it is opened or shut. A pair of T-hinges, commonly known as *cross-garnets*, must then be screwed to the jamb A and the ledges as shown in Fig. 2. Hinges of this description vary considerably in size, the smaller kinds being used for box-hinges and the larger kinds for doors. For a light door, the tongue of the hinge, that is to say, the part which is screwed to the ledge, should not be less than 9 in. and the cross piece about 4 in.; for heavy doors a larger and stronger hinge should be used. Lastly, the latch of the door must be put on, and this may be a simple thumb latch unless a spring latch or lock is preferred. If a thumb-latch is used, a small block of wood U, the same thickness as the ledge, must be fixed to the door, and to this the plate of the lifting bar of the latch must be screwed, the catch into which it drops being fixed to the jamb B. A hole must be cut through the board M and the block U to admit of the insertion of the lever by which the bar of the latch is lifted. If greater strength is required the ledge door may be enclosed in a frame and the boards may be 1 in. in thickness. In this case the stiles or sides of the frame are grooved to take the tongues of the outside boards and the middle board cut to width and tongued to fit the extra groove. Such is the ledge door, and as this is the kind of door which will be chiefly made

by the amateur for his sheds, tool-houses, and outbuildings of every description, except greenhouses, care has been taken to describe every part of it, and to show its construction and the mode adopted in "hanging" it, as clearly and fully as possible.

Panelled Doors.—A panel door is much more elaborate in its construction, and consists either of a simple single panel in a frame, as used for dwarf cupboards, or two, four, or six panels, enclosed between styles and rails. The reasons why doors are made in this manner are, firstly, because they present a better and far more satisfactory appearance than a door with an almost plain and unbroken surface; secondly, because it is far lighter than a door would be made of the same thickness throughout as the wood which is used for the styles and rails; and thirdly, because less wood is used in its construction. This effects a saving in the cost and quantity of material used; but when the door is made by hand and not by machinery, it is counterbalanced by the extra time taken in making, and the consequent extra cost of labour.

As a suitable example of a panelled door, we may take a four-panelled frame door, because it will afford the key to the mode of making most doors of this description, whatever may be the number of panels used.

In Pl. K, Fig. 5, the various parts which enter into the construction of the panelled door are shown in such a way as will make clear the manner in which they are framed together. The parts are three rails, or cross-pieces A, B, and C, of which B and C are always wider than the top rail A; two long styles, D and F, forming the sides of the door, and two short styles, E and G, in the centre between the rails technically termed mullions or muntins; lastly, there are four panels, H, I, J, and K, which are inserted in grooves cut in the styles and rails for their reception. With regard to the dimensions of the door and its different parts, these must be left to the amateur that he may adapt them to his special requirements. It may, however, be said that the panels are generally made of sound, straight-grained ½ in. stuff, and that the styles and rails range from 1¼ in. to 2 in. in thickness; the styles are generally about 4 in. in width, the top rail about 5 or 6 in. wide and the middle and bottom rail about twice the width of the top rail.

An examination of Fig. 6 will show that tenons must be cut at the ends of the rails A, B and C, which fit into corresponding mortises in the styles. Tenons are also cut at the ends of the short

styles E and G, which fit into mortises in the rails A, B and C. In the *inner* edge of the two long styles and the top and bottom rails and on both edges of the short styles and centre-rail grooves must be ploughed about ½ in. deep to receive the edges of the panel, which therefore must be made about 1 in. wider than they seem to be when the different parts of the door are all brought together. In the common and cheaper form of doors nothing more is done, but in the better-made doors it is usual to finish one or both sides with a moulding. The moulding should be of such a thickness as to be flush with the styles and rails in its thickest part. When a six-panel door is made, the second rail from the top is technically known as the "frieze" rail, the others retaining their ordinary names as for the four-panel door. In doors of this description the middle rail is sometimes called the "lock" rail. In making entrance doors and other doors in which great strength is required, and frequently in doors in which the styles and rails are not more than 1¼ in. in thickness, the panel is rebated, so that one side of the panel may be flush with the style. When this is done it adds very much to the appearance of the door if a bead is run round the edge of the rebated part of the panel.

As the doors of rooms as a rule open inwards, the stops must be put on, as in the case of the ledge-door above described, on the outside. In this respect doors of rooms differ from cupboard doors, which of course open outwards.

The styles and rails of doors for cupboards, wardrobes, bookcases and all kinds of articles of this description are of course made of thinner wood than that which is generally used in the construction of room doors and some modification of the methods described above will therefore be necessary. In the case of an ordinary dwarf cupboard door the frame may be made by merely joining up two styles and two rails. Both styles and rails should be rebated on the inside, and a panel fitted into the rebate, being held in place either by means of brads on the inside or a moulding. A nice appearance is given to a door of this description by using a bead for this purpose. This bead is preferable to a moulding in all articles of furniture which are stained and varnished, or French-polished. It should project slightly beyond the face of the frame of the door.

Door Hinges.—All doors of rooms and cupboards are hung with hinges technically called butts. These hinges are made of two pieces of cast iron or steel of equal size, longer than they are

wide in the proportion of about three to one, furnished at the inner edge, one with two or three loops, and the other with one or two loops. In a butt hinge, the three loops are on the inner edge of one flap and two loops are on the inner edge of the other flap. The loops of the two flaps are fitted together, and a stiff pin, on which the "butts" turn, is passed through them. Hanging a door or window is a delicate and troublesome operation. When the hinge is closed, the edge of the style of the door on one side, and the door jamb on the other should not quite extend to the centre of the pin on which the butt turns, and the depth of the recess should be the same as the thickness of one flap or leaf of the butt. The correct positions of the hinges are 6 in. from the top and 10 in. from the bottom of the door. The size of the recesses should be marked by holding the hinge itself in the position in which it is to be fixed and running a pencil round it. The recesses for the butts may then be cut out with the chisel. In this matter the greatest nicety is required. The effect of letting the butt in too far is to cause the door to grind against the frame when it is opened; if not let in far enough, an ugly gap will be visible when the door is open. Similar difficulties will result from incorrectly gauging the depth to which the recess is to be cut. If by some mischance, too much of the wood has been removed, a thickness or two of brown paper or cardboard, must be put under the hinge to diminish the depth. When the butts have been let into the door and screwed on, the door should be placed in position, and blocked up in the manner described above in connection with the ledge door. The hinges should then be opened and their places marked on the frame. Afterwards the door can be removed and the recesses in the frame cut out. Before finally screwing the hinges to the frame it is desirable to temporarily fix the door with one screw in each hinge, and to see if it works easily. The amateur should not be discouraged by failure in his early attempts, as very few will hang a door or casement window so as to work with perfect ease at the first essay and even an experienced hand will sometimes spend an hour or so over such a piece of work.

In connection with the above remarks on doors, and the method of making them, the reader will understand that it is impossible to describe pieces of furniture in completeness of detail in every part, as, for example, to give directions for making a cupboard, wardrobe, or bookcase, and go into the minutiæ of door-making, with each article; but, from what is said here on the modes of making different kinds of doors, the amateur need not be

Plate K. WINDOWS, DOORS, AND GATES.

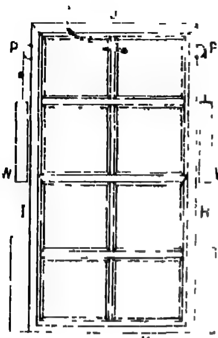


Fig 1

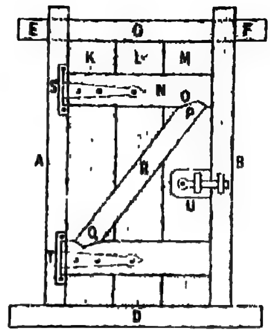


Fig 2

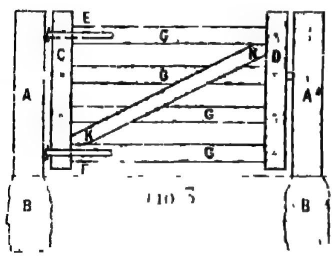


Fig 3

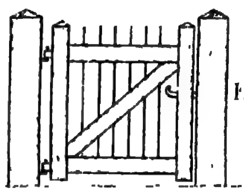


Fig 4

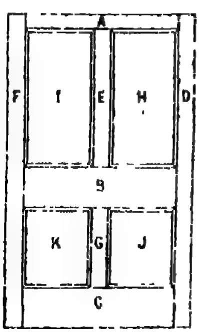


Fig 5

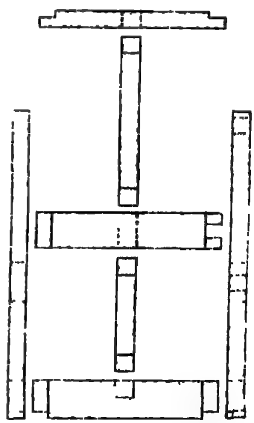
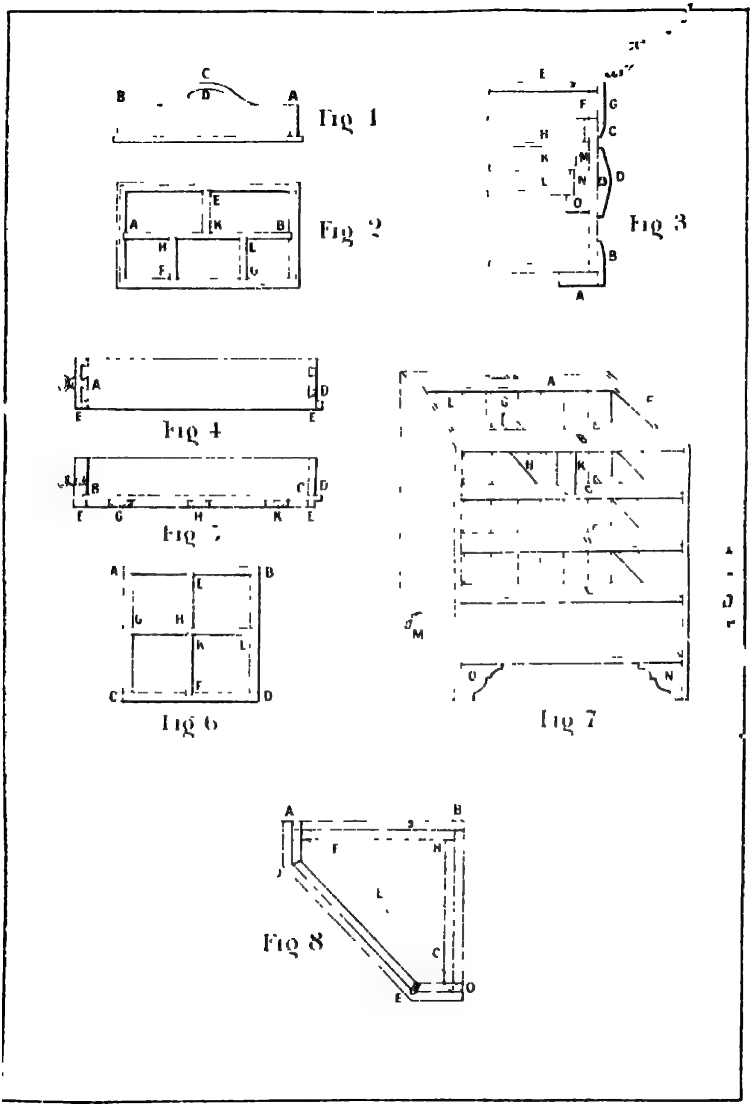


Fig 6

Plate L. BOXES, DRAWERS, etc.



(1 and 2) Nail box (3) Section of tool box (4 and 5) Construction of drawer, (6) Pigeon holes (7) Framework of chest of drawers (8) Corner cupboard

at a loss to know how to proceed when he is engaged in making any of the articles that have been mentioned. The information given has, in all cases, been rendered as broad and general in its application as possible, so that with regard to any branch of carpentry, joinery, or building work, what is merely hinted at in one part of the work, taken as a whole, will be found fully and minutely described in another. The object chiefly in view has been to help the amateur to make anything and everything that it is possible for him to make, and not to give detailed descriptions of a few articles with regard to length, breadth, and thickness of every part, and the manner in which these parts must be put together.

Gates.—The amateur artisan will perhaps be called upon at one time or another to make a gate, which is nothing more than a door formed of styles and bars or rails, instead of being solid. It is not proposed to enter into the many ways in which gates may be made, and all that can be done here is to describe the general principles upon which all gates are made. For this purpose it will be enough to describe the ordinary field-gate, a little wicket-gate, and a garden-gate, of rather more elaborate construction, intended to close the entrance from the roadway into a garden in front of a house.

Ordinary Field-gate (Pl K, Fig. 3).—The supports of the ordinary field-gate are formed by two stout posts, the lower end of each being left rough so as to give them better holding when put in the ground. A hole having been dug for the posts, they must be set upright by aid of the plumb-level and then surrounded with pieces of brick, stones, gravel, lime core, etc., which must be beaten in tight with a rammer. To make the gate, two styles, are first cut out, the style to which the hinges are fixed, being known as the hanging style, while the style to which the latch is fastened is called the falling style. Five or six rails are then mortised into the styles and wedged up as tightly as possible. The hinges are fixed to the top and bottom rails. They consist of a strong loop of iron, which passes over a pin driven into the gate-post, and two tongues or straps, which extend to some distance along the top rail on either side, and pierced at equal intervals with holes through which small bolts are driven and riveted. It will be obvious that the gate, being longer than it is wide, will by its weight exercise a great strain on the hinges and have a tendency to drop towards the ground. To prevent this

and keep the end of the fallen style from touching and dragging along the ground, struts should be put across the gate from corner to corner. By this means the strain is taken off the rails and thrown on the bolts and straps of the hinges. The ends of the struts are butted against the styles. Sometimes only one strut is used. In this case the direction of the strut should be from the angle formed by the hanging style and the bottom rail diagonally across the gate so as to support the end of the top rail.

When a light but strong gate of this description is desired, the strut and styles are made of the same thickness and framed together in the same plane. Holes are then bored through the styles and the strut, through which round bars of wood are driven and wedged up at each end.

Field-gates are fastened with a hook attached to the gate and falling into a staple driven into the post, against which the gate falls. Park-gates and entrance-gates of this description have a hole cut in the falling style, through which the iron latch is passed. This latch works on a pin driven through the style, and the gate is secured by the bar dropping into a notch cut in the piece of iron of some thickness, which is attached to the face of the falling-post.

Garden-Gate (Pl. K, Fig. 4).—The method of making a smaller gate for the garden entrance is similar to that described above, but the rails and struts should be somewhat narrower than the styles into which they are mortised, and to give lightness of appearance the rails and struts and styles should be stop-chamfered. Holes are then bored in the top and bottom rails and the strut, and through these bars of iron about ½ in. in diameter are driven. Strap hinges should be fastened to the rails, as in the case of the field-gate, and these hinges rest on perforated plates driven into the hanging post or otherwise secured. An iron bar is then passed vertically through the loops and plates and on this bar the gate swings.

For a garden gate at the entrance from a roadway, the kind of gate just described will not be sufficiently ornamental in character, though it may be substantial enough for all purposes for which it is required. An infinite variety of designs is to be had or made for gates of this class, but the most convenient will be found to be a gate that while solid below is given an appearance of lightness by being pierced above. The lower part may be panelled, the upper part barred; or all the openings may be filled with iron open-work castings which may be bought for this

purpose; but in this case the castings must be obtained first of all, and the frame of the gate then made to suit them. In another type of garden gate the lower part is filled with substantial boards, forming one large panel. In the upper part, the corners are filled with pieces cut to form an oval or ellipse on each face, but chamfered or hollowed within so as to form four points springing out from the under edge of the curve. The open centre is partly filled with a simple ornament in wrought iron, consisting of flat bars halved together at the centre, and having shorter pieces springing from each side of the arms of the cross.

CHAPTER IX

BOXES, DRAWERS, BOOKSHELVES, AND CUPBOARDS

Boxes and Drawers.—In all the various articles to be treated in this chapter there is a certain degree of similarity. As a rule, all of them are rectangular in form, the chief exceptions being the chest of drawers with circular or elliptical front, and the old-fashioned three-cornered cupboard fitted into the angle or corner of a room, but now very seldom used. Boxes and drawers are rectangular receptacles devoted to various purposes, and differing somewhat in construction according to the purpose for which each is intended; but, putting aside minor differences of construction, a box may be regarded as a drawer with a cover to it. Again, a chest of drawers is but a set of pigeon-holes on a large scale, fitted, for greater convenience, with drawers that move in and out of the pigeon-holes. Thus it will be convenient to begin with the simplest form of box, and so proceed onwards, as the construction of one kind of article in the above category generally proves to be a guide in the construction of another.

Various Kinds of Boxes.—The word *box*, in its primary signification, means "a hollow wooden case": the term is applied to cases without covers as well as cases to which covers are attached. The simplest form is to be found in the window-box for plants, which, when it is devoid of all ornamentation, consists merely of four sides and a bottom. The amateur mechanic's nail-box, and the housemaid's box for blacking brushes, etc., are merely modifications of the window-box on a smaller scale. The knife-box or knife-tray, and all boxes of this description for household use, to hold cutlery and plate, are closely akin in form to the boxes that

have just been mentioned. Let us first see how boxes of these kinds are made.

The Window-box.—The length and breadth of the window-box must be governed in all cases by the dimensions of the window-sill on which it is to stand. Supposing that it is desired to make a plain box devoid of ornament, and in the simplest manner possible, all that has to be done is to cut out the ends and the sides of the intended box, and then to nail the long sides of the short ends. A frame is thus formed, and all that is necessary to be done to convert the frame into a box is to nail on a piece of board of the requisite size to form a bottom. Additional strength may be given to all boxes and cases constructed in this manner by nailing strips of iron, bent so that one half is at right angles to the other half, at each corner of the box, and over the sides and bottom.

Now in making a box in this way, which is the plan generally adopted for common boxes and packing cases of all kinds, no very great amount of skill is required. All that is necessary is that the various parts should be cut square, so that the box itself may be truly rectangular in form, when completed. A better method which is sometimes adopted in making small boxes, such as nail-boxes, etc., is to plough grooves in the sides at each end, into which the pieces forming the ends of the box may be dropped (see Pl. IV, Fig. 1). The simpler, though weaker, method of merely nailing the parts together as previously described is shown in Pl. D, Fig. 1. The amateur who has acquired a more complete knowledge of the various joints used in carpentry will choose neither of these methods when he wishes to form a stout and strong case, but will dove-tail the ends and sides together in the manner described on p. 119. In order to give a more finished appearance to such a box as that described above, he will also allow the bottom to project slightly about ¼ in. beyond the sides, and will round off the edges so that the projection assumes the form of a bead or circular moulding. This mode of procedure may be adopted for a nail-box, housemaid's-box, or window-box.

In the case of the window-box a little decorative work is often a great improvement. The ends, the back, and the bottom may be made of plain wood in the usual way, but the front should be framed with two rails and four uprights, which are stop-chamfered. The uprights divide the front into three compartments. The panels thus formed may either be filled with tiles

or with pieces of wood sunk sufficiently below the framing to admit of an overlay of fret-work. A strip of moulding is added above the frame, and this moulding must be returned round the sides. The edge of the bottom board on which the framed front rests and the edges of the same board at the sides are moulded and below the moulding a strip of wood cut in scallops is fixed. This serves to cover the space between the bottom of the box and the sill of the window formed by the slope of the sill. It is necessary that the box should stand level, and therefore slips of wood, should be nailed to the bottom of the box, one at each end and one in the centre, or even more, at equal distances from each other, and from the slips at the ends if the box be more than 3 ft. in length. If fretwork is used to fill the panels, it may be treated in various ways. If the frame and panels are of dark wood a piece of light wood may be put in behind, so that the design may show in agreeable contrast to the frame. Tiles may also be set behind the pierced panels or, as it is desirable to have a zinc lining for such boxes as these, the zinc front will serve to fill the open spaces and may be painted, or otherwise treated, according to the taste of the maker. The zinc box, which is fitted into the outer case, should be made of stout metal and wire rings should be attached to the ends so that it may be lifted out of the case when necessary. In order to provide proper drainage, before plants are placed in the zinc case, arrangements should be made for surplus water to run away by piercing the bottom in one or two places. Similar provision for drainage must be made in the construction of the bottom of the wood case. A good plan is to form the bottom of several narrow battens, with a space of about ½ in. between each. In order to prevent the waste water trickling down the face of the wall a shallow zinc tray, fitted with an inch or two of compo pipe, should be placed between the box and the window sill. When plants in pots are placed in the case and the interstices between the pots filled with moss, which will tend to keep the pots cool and moist, no crocks, etc., need be put at the bottom of the zinc case; but if the case is to be filled with earth the bottom must be crocked to the depth of 1 in. at least.

The amateur will discover for himself many desirable methods of ornamenting the front of a window-box. One of the most suitable modes of doing this is to cover the entire front with the bark of the cork tree, commonly called "Virgin Cork."

The cork may be obtained from any firm dealing in horticultural supplies and is obtainable in parcels of 7 lb. In orna-

menting a window-box in this way, an excellent effect is produced by simply nailing on pieces of cork of irregular shapes so as to cover the whole of the front and even to project in places over the edges and so break the straight lines. By this means a rustic appearance is given to the box, which is far more artistic and pleasing than any formal arrangement.

Another very effective mode of decorating the front of a window-box is to cover it with pieces of hazel, larch, or other wood with the bark on, arranged in patterns over the surface. The sticks or rods must be cut in short lengths, and then split or sawn in halves, so as to present one flat surface, which is to be placed against the wood, the rounded side being placed outwards. For their better preservation the sticks forming this exterior covering of the box may be varnished or oiled.

By using alternate sticks of light and dark wood such as peeled willow and chestnut, a kind of rustic mosaic may be formed. For fixing the lengths of stick in position oval brads should be used as these will not split the wood.

Nail-Box. (Pl. L).—As a general type of boxes of this kind, let us take the nail-box, since this is a box which every amateur artisan must have. The elevation of a box of this kind when viewed from either side is shown in Fig. 1, the plan in Fig. 2. It may be as large as the maker pleases, but a box from 12 in. to 15 in. long, 9 in. or 10 in. broad, and 2½ in. or 3 in. deep will be found the most convenient size. The wood may be ordinary deal, ¾ in. thick before being planed, or planed stuff ⅝ in. thick may be used. The sides and ends of the box must first be framed together, the tenons being cut on each side of the ends and the dovetailed mortises or notches, into which they are dropped, in the sides. Before the ends and sides are put together, grooves must be cut at A and B, in the ends to receive the central partition A B, which should be nearly twice as wide as the sides. This piece of wood must be cut in the shape shown at C in Fig. 1 and pierced with a longitudinal hole, as at D, for convenience in carrying the box. Grooves must then be made in the sides at E, F, and G, and in the central partition at H, K, and L, to receive the partitions E, K, H F, L G, the tops of which must be flush with the edges of the sides and ends.

The central partition in which the handle will be formed should be of the same thickness as the sides, and the grooves made in the end pieces for its reception should correspond in width. The cross partitions should be made from ½ in. wood and the grooves

for these will therefore be narrower. In each case the depth of the groove should be about ⅛ in. The side of the box with two partitions should be put together first and the partitions secured from moving by means of brads driven into them through the sides. Then the partition E K should be inserted, and the remaining side put on; or, what may be better, the ends and partitions may be first bradded to the central piece, and then the whole locked together by putting on the sides. Lastly, the bottom must be put on, which should be nailed to the sides and ends, and project slightly beyond them, as shown in the plan in Fig. 2.

Housemaid's Box.—Now simple modifications of this kind of box will do for the housemaid's box, and the knife-box or plate-box. The housemaid's box will only require a central division and one subdivision, as at H F or L G in Pl. L, Fig. 2, for the black-lead dish. The box for knives or plate will require the central division only, but it should be made of mahogany, and, when intended for silver, be lined with green baize. Sometimes knife trays, especially when intended as a means for collecting the knives and carrying them from table after they have been used, are made with the sides and ends slightly sloped, so that the bottom is narrower and shorter than the area enclosed by the upper edge of the ends and sides.

Thus for boxes of a plain ordinary description—and it may be noted here that the method to be employed in making boxes or cases of every description is precisely the same—first of all, the ends and sides are to be nailed or dove-tailed together, and then the bottom is to be nailed on from the outside. No ornamentation is required or desirable in boxes of this description.

Boxes with Lids or Covers.—We may now consider boxes made with covers, the covers being attached to the receptacles or cases over which they are fitted by means of hinges. The sides and ends of all boxes must be, or should be, dovetailed together, especially when the wood is not hidden from view by chintz, cretonne, or damask, or any other textile material, as in the case of an ottoman-box; or by leather, leather-cloth, or painted canvas or hessian, as in the case of a trunk or travelling box.

The cover of an ordinary box consists of nothing more than a piece of wood, or two or three pieces glued up and clamped together if necessary, cut flush with the sides and ends of the box.

A slip of wood or a rounded moulding is then put round on the edge of the cover, and this moulding comes from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. over the front and ends, and whilst improving the general appearance of the box, serves to keep out dust which might otherwise penetrate more easily. This moulding is put on the front and ends only of the cover. It must not be fixed on the back, as this would of course prevent the box from being opened. Sometimes, when it is desirable to make a very neat job and to conceal the edge of the bottom from view, the lower edges of the back, front, and ends are rebated and the bottom is then cut so as to drop into the rebate. Again, when the edge of the bottom shows all round, having been cut flush with front, back and ends, and nailed to them, it may be hidden by a moulding, or slip of wood with a bead as the top, nailed round the bottom of the box, so as to form a plinth. Lastly, when boxes are intended to hold clothes, tools, etc., and to stand on the floor, it is desirable to nail a slip or ledge of wood to the bottom at each end and, if the box be a large one, in the middle, so that there may be a free passage for air right under the box, as well as around and above.

Fittings for Wooden Boxes.—The fittings used for a wooden box are the hinges, the lock, and the handles. For small boxes, long narrow brass hinges, made like the iron butt hinges, are used, but for larger boxes a hinge known as a wrought chest hinge is used. This form is fitted with an iron strap which is screwed to the inside of the cover. In general character it is similar to the T-hinge, the principle being the same, although it differs somewhat in shape.

Locks for Boxes.—The ordinary box lock is shown in Pl. XIX, Fig. 2. This must not be confounded with the hasp-lock used for trunks and portmanteaus, whose construction will be explained presently. To fit this lock, an indentation of sufficient depth to receive the plate is cut in the edge of the front of the box, so that the upper surface of the plate may be flush with the edge of the box. The inner surface is then recessed slightly to receive the plate but a deeper hole or indentation is cut away to receive the box which holds the bolt, etc., of the lock. A hole must then be made through the front to admit the key the barrel of which fits on over the peg or spike. Care must be taken not to cut away any more wood than is necessary to admit the box of the lock, otherwise there will be nothing to hold the screws which pass through the four holes and which fasten

the lock to the inside of the box. Lastly, the link plate or hasp must be screwed to the inside of the top in such a position that it may drop easily into the lock. This position may be ascertained after the lock has been fixed by locking the loose hasp in and letting the lid fall sharply on the sharp points projecting from the upper part of the plate. It should then be unlocked, and if the lid is carefully lifted, the link plate will be found on the lid in the exact position in which it is to be let in. There is no great difficulty in fixing a lock of this kind, but it is a piece of work of some nicety and requires time and care.

Boxes, especially when filled, are heavy and awkward to move, and for this reason it is desirable that iron handles should be fixed to them, one at each end. The handles commonly used for this purpose are shown in Pl. XIX, Fig. 1. To a plate in which are four holes for screws, two projections are attached. In these projections are holes into which are inserted the ends of a swing handle, the ends of the handle being constructed in such a manner that the handle will lie flat against the plate, or be turned upwards just so far that it stands out at right angles to the plate and no farther.

The Tool-Box.—The remarks that have been made refer to the construction of boxes generally, but they will be found applicable in many points to the boxes which we are now about to describe. Of these we will first take the tool-box, because it is one which the amateur must have, and which, without doubt, he will desire to make for himself.

The general mode of construction having been dealt with, it will only be necessary to consider convenient methods of arranging the interior. First, it is necessary to point out that the lid or cover of the box must be made deep enough to receive a number of tools to be held within it. A depth of 1½ in. will be sufficient. The rim of the lid should be of the same thickness as the ends of the box and made to fit exactly upon the lower case. A hasp-lock, such as is used for a trunk, would be suitable for a box of this description, but a box-lock may be put on equally well. Within the lid may be placed the hand-saw, tenon-saw, square, key-hole saw, pincers, drill and a few smaller tools. The best way of securing the tools is by means of blocks with small buttons of hard wood attached in such a way that they may be turned over the tools and keep them in place, with loops or ledges to take the blades of the saws,

square and similar tools. Below, on the bottom of the box, large tools, such as planes, the wooden mallet, oil-stone and hammers are kept with the long large rasp used for wood. Along the back, strips of leather are nailed to hold small tools such as bradawls, gimlets, files, etc. At the top of the right-hand side of the box is a till with a cover in which may be kept such tools as chisels, gouges and the various kinds of boring bits used with the stock. On the left-hand side of the box are several sliding trays arranged over one another and divided into compartments for screws and various small fittings and iron-mongery commonly used in carpentry. Nails are better kept in the nail-box than within the tool-box. Below the tray, on the right-hand side and covered with a sliding panel resting on slips nailed to the side of the box, is a recess in which the glue-pot, oil-can, and bottles of varnish, etc., can be put away; whilst beneath are two small drawers, which may be dispensed with if the box is not deep enough for them.

The kind of tool-box just described will be found very useful by the majority of amateurs; but for those who may not like this method of arranging the interior, and who may require more room the longitudinal section (Plate L, Fig. 3), shown in part only, of a box 2 ft. 9 in. long by 16 in. broad, may prove acceptable. This box is 21 in. high, the thickness of the wood of which it is made and the depth of the different compartments within being shown in the figure. Ledges A, on which the box stands, are nailed to the bottom, and round both the upper and lower edges of front, back, and ends slips of wood are nailed, forming a plinth B below, and a projecting ledge C above. To the ends stout pieces of wood D are nailed, through which are passed pieces of rope to serve as handles. The lid E is made with a double rim, so that the inner rim F rests on the box, and the outer rim G on the ledge outside, nailed round the top of the front, etc., so that the box is dust-proof and almost watertight. Within are three trays, H, K, L, each about 2½ in. deep, resting on ledges M, N, O, graduated to take the trays, and screwed on to the ends inside the box. Below the third tray L is ample room for all large and heavy tools—such as planes, etc.; the saws can be secured to the top of the box, within the lid, as in the foregoing example, and so can the square and bevel. All the other tools can be disposed in the trays as may be most convenient. Some readers might object to this arrangement that considerable loss of time and trouble would be involved in lifting out and replacing the trays in order to get at the tools which are stowed away in

them: This, however, is obviated by making the trays just half the width of the box, and fixing rings or knobs to the front, by means of which they may be moved on the ledges from the back to the front of the box, thus exposing the interior of any of the trays without touching the others. Thus it will be seen at once that the tools in the bottom of the box can be taken out and put back again at pleasure without removing the drawers or trays. This mode of making a tool-box and fitting up the interior is recommended to the amateur as being very convenient, enabling him to get at any tool he may require without delay or trouble.

Travelling Trunk.—In recent years, the travelling trunk has been largely replaced by the leather trunk, the basket travelling trunk and telescopic baskets, but for the assistance of those who may still prefer the older and more substantial form we may proceed to consider the construction of a travelling trunk suitable for general use. A trunk should be made in such a way as to provide three compartments below and a tray above (in which suits or dresses may be packed without creasing them). The dimensions of such a travelling trunk may be left to the discretion of the maker, who will know his own requirements, but for ordinary purposes a box 3 ft. long, 18 in. wide and 15 in. high will be found to be of useful size. First of all, the case or lower part of the box must be made in the usual manner, and as the box must be covered with leather or canvas, which should be painted, the sides, ends and bottom may all be nailed together to save the time which must otherwise be expended in dove-tailing ends and side. The cover must be made to fit exactly over and flush with the sides and ends. The top may be flat or rounded. There is no difficulty in making an arched or domed top. All that is required is to cut the two ends of the cover in the form required, and then to nail boards across from end to end, bevelling the edges of the boards as may be necessary, so that they may be brought accurately and closely together. The case and the cover must be connected with hinges and a hasp-lock fitted, the lock itself being put on from the *outside* of the box, and the hasp that fits into it to the outside of the cover. We will speak presently of the mode to be adopted of finishing off the exterior of the box, and turn at once to the fitting up of the interior.

To divide the box into three compartments slips must be nailed to the sides so that each pair forms a groove, and in the grooves thus formed a thin board slips up and down, removable at pleasure, so that if necessary the box may be thrown open from

one end to the other. The utility of the boards, is manifest, for while the outer compartments may be closely packed with under-linen, etc., the central one may be occupied with hats and bonnets without any chance of their being crushed; or, if these be carried in a separate bonnet-box or basket, with boots and other articles that it may be desirable to keep apart from the wearing apparel.

The tops of the slips that form the grooves, the tops of the boards that divide the box into compartments, and two ledges, screwed on, one to each end, inside will form a sufficient support for the tray—which is a frame 3 in. or 4 in. in depth, with a few pieces of webbing stretched across it, and nailed to the edges to form a bottom. The tray should not be made to fit too tightly within the sides of the box, but so that it may slip in and out with ease. The tray should project above the top of the case, so that the cover closes down over it when the box is shut. The use of the domed top is now obvious, for it is clear that there is more room for dresses, etc., that may be laid in the tray than if there had been a flat top to the box, fitting close over the tray. As the box is to be covered with some kind of material, such as leather or canvas, it is not necessary that the boards of which it is formed should be planed up on the outside, though it will be well to smooth them over on the inside instead of lining or papering the box within, a plan followed by the professional trunkmaker, not so much for the sake of ornament or neatness as to conceal the roughness of the boards which are left unplaned. For a box of the dimensions given above, sound board of ½ in. or at the utmost ⅝ in. in thickness will be sufficient. If the wood be thick enough butt hinges of brass may be used or hinges consisting of two straps connected by a pin may be screwed on from the outside and made to form part of the ornamentation of the box. Strong tapes should be attached to the cover of the box at one end and the case at the other to prevent the cover from falling back too far when the box is opened.

Leather will generally be found to be too expensive for the material to be used for the outer covering of the box and the amateur may save considerable outlay in this respect, by using canvas or hessian which must be painted black after it has been stretched over the top and sides, and securely nailed to the edges. American leather-cloth has a nice appearance when first put on, but it is very susceptible to injury from rough usage at railway stations when travelling. When the canvas has been put on and painted, a ledge of wood

should be nailed all round the bottom to keep it from coming into contact with any surface on which it may be placed, and which may possibly be wet. A flap of leather should be nailed all round the cover, so as to keep out any water which might otherwise penetrate when the trunk is exposed to the rain. This strip of leather should be nailed along the cover about ¾ in. above the line where the cover and the sides meet. A strong strap and buckle should be placed on each side of the lock to take off part of the strain from the hasp of the lock. Lastly, angle-irons lacquered with black varnish should be placed along the edges of the box; those at the bottom having been put on before the ledge, to which reference has been made above, is nailed to the bottom.

Drawers in Articles of Furniture.—A drawer is a box without a cover, made in such a manner that it may be easily pulled out from or pushed into a case or frame which is specially made to receive it. An assemblage of drawers, fitted into a single frame, is called, together with the frame in which the drawers are placed, a chest of drawers. Drawers enter into the construction of many articles of furniture, as, for example, library tables, kitchen tables, side tables, dressing tables, washstands, wardrobes, kitchen dressers, and cabinets; the principles of construction, however, are in every case the same, and on this account it will be more convenient to consider the construction of the drawer separately, without special reference to any article of furniture of which it may form a part.

Principles of Construction of Drawers.—A drawer, as a general rule, must be rectangular in form. The only exceptions to this rule are in drawers that fit into chests of drawers having rounded or elliptical fronts, when the front of each drawer must of necessity be curved in accordance with the shape of the frame in which it is placed. The way in which a drawer is made may be understood from the diagrams in Pl. L, of which Fig. 4 represents the elevation of a drawer when seen from the side, and Fig. 5 the section of a drawer. Fig. 4 shows how the front, back, and sides of a drawer are dovetailed together. As it is desirable that the front of the drawer should present one unbroken surface, the outer end of each side is dovetailed to the front, as shown at A. The details of this particular kind of dovetailing have been given in full in Part I, Chap. V, and need not be repeated here. Grooves are made along the inner surface of the front and sides a short

distance, say ¼ in. above the lower edge, to admit the bottom, which is made of thinner wood than the front, back, and sides of the drawer. The back of the bottom generally projects a little beyond the sides, as shown in both figures at D, and the back of the drawer reaches and rests upon the bottom as shown between C and D in Fig. 5. The mortises and tenons are glued up, and the edges of the bottom are glued in front and at the sides and the parts are then put together and closed up, nails being driven through the tenons of the sides into the front and back to aid in keeping the whole together.

The lower edges of the sides of the drawers, as shown at E F, act as runners on which the drawer is pulled out and run in. As the edges of the sides of the drawer are the only parts that rest on the framing within when the drawer is in motion, it is obvious that the friction is far less than it would be if the lower surface of the bottom were in the same plane with the edges of the sides. Sometimes the bottom is strengthened by putting small blocks in the angle formed by the lower surface of the bottom of the drawer and the inner surface of the sides just below the groove, as at G H and K. The method of fitting the lock is similar to that already described in the case of the ordinary box-lock. Considerable care is necessary, however, in cutting the bolt hole in the rail above the drawer, as the slightest inaccuracy will be sufficient to prevent the bolt from being raised when the key is turned. The best way to mark the position of the hole is to smear the top of the bolt with black paint and after the drawer has been shut to turn the key smartly several times so that the bolt is forced up against the rail. The portion of wood to be cut away for its reception will thus be marked on the rail. The hole may afterwards be cut with the special tool known as a drawer lock chisel. When the knobs, which serve as handles to pull the drawer out or push it in, are put on the drawer is complete.

Drawer handles and drawer pulls, in brass or other metal, may be obtained at the ironmongers in a great variety of more or less ornamental patterns. Handles suitable for chests of drawers and office or shop furniture are shown in Pl. XIX, Fig. 1.

Pigeon holes.—The principles which govern the construction of a nest of pigeon holes for the reception of paper or the storage of phonograph records are shown in Pl. L, Fig. 6, which will serve this purpose as well as a more elaborate drawing of a complete set with a much larger number of holes. The size of the pigeon-

holes and the length, breadth and depth of the entire framing having been determined, two boards, A B and C D, must be cut and planed up for the top and bottom, and two others, A C and B D, for the sides. Grooves must then be made in the top and bottom on the inner surface at E and F for the reception of the vertical partition E F and also on each side of the partition at H and K and the inner surfaces of the sides at G and L for the reception of the horizontal partitions G H, K L. When this has been done the pieces of wood A B, C D, A C, and B D must be put together—dovetailing at each angle of the frame is the most desirable and efficient mode of joining them—and then the upright partition E F must be gently driven into the grooves cut to receive it, and lastly the horizontal partitions G H, K L. In the small set of pigeon-holes under consideration it is unimportant whether the vertical or horizontal partition be in one piece. A safe rule for general guidance seems to be that *when the length of the pigeon-holes is greater than the height, the horizontal partitions shall each be in one and the same piece from side to side, the vertical partitions being grooved into them and the top and bottom; but when the height is greater than the length, the vertical partitions shall each be in one and the same piece, and the horizontal partitions grooved into them and the two sides.*

Such is the general method adopted in making pigeon-holes. Many modes of ornamenting them will readily suggest themselves to the amateur—as for example, by a pair of doors panelled and adorned with fret-work; but this may be left to the maker's good taste, judgment, and requirements. They may be easily turned into a set of drawers for holding small articles, as is often done in chemists' shops and many houses of business, where a number of small, convenient receptacles for many different kinds of small articles are required.

Chest of Drawers.—We may now proceed to a consideration of the framework of a chest of drawers, which is, in fact, nothing more than a set of very large pigeon-holes; but in order to save material and to render the article less weighty when completed, only just so much of the framing is inserted as may be absolutely necessary for the support and division of the drawers. For this reason the framework of the chest of drawers may be looked upon as being a set of *skeleton* pigeon-holes.

In the construction of a chest of drawers such as that shown in Pl. L, Fig. 7, the sides and bottom of the framework may be of inch pine about 18 in. wide. The bottom is run into a V-shaped

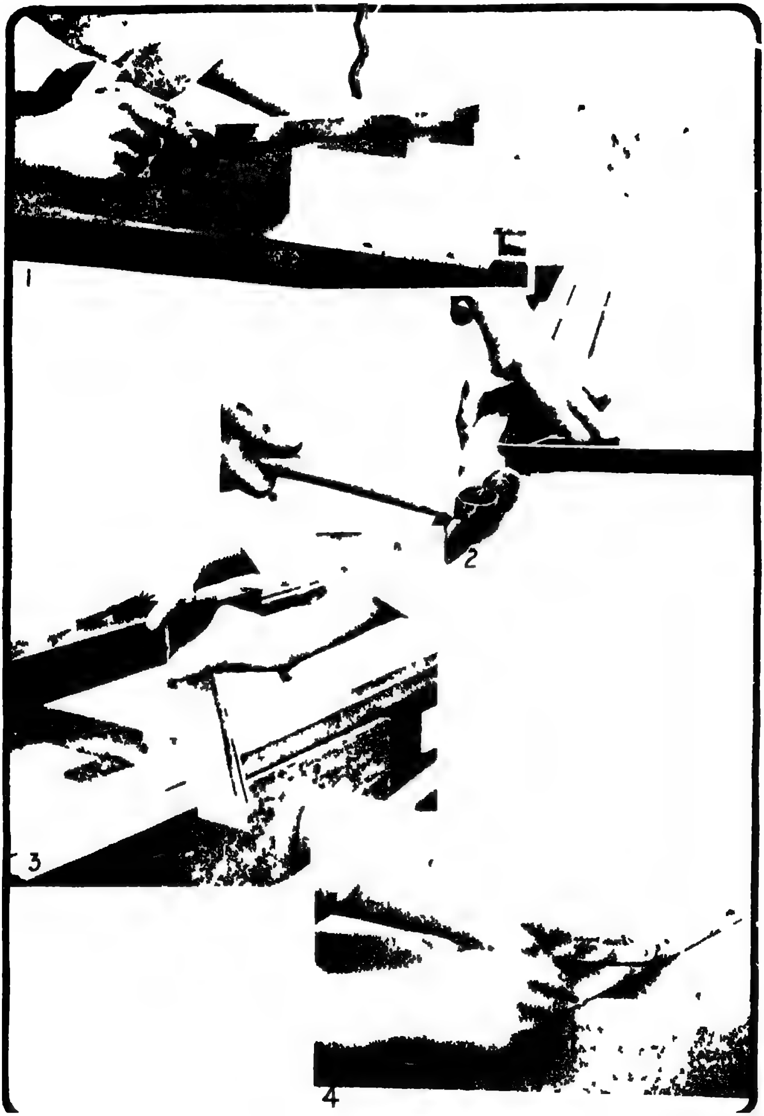
groove in the sides as this affords continuous support to the edges on both sides and does away with the unsightly appearance that would be presented if it were mortised into the sides. The bottom should be blocked round to impart additional strength to this part of the structure. The cross pieces A and B are dovetailed into the top edges of the sides, and these serve as ties to hold the sides together. The ledges C, D and E, upon which the fronts of the drawers will rest, are also mortised into the sides, but the ends of the tenons must not appear on the outer surface. The ledges or bearers which run from each of these to the back are also attached to the sides by screws after being glued in position. A piece of inch stuff—3 in wide or a little more is halved into the top rail A as shown at G. A horizontal ledge H is mortised into this upright and the rail C, to serve as a bearer for the sides of the small top drawers; and in order to keep them apart when being drawn out, an upright, K, is mortised into B and C and a vertical rail about 1 in. or 1½ in. deep screwed along the centre of H. The interior is now complete and the back must be put on. This consists of alternate pieces of ½ in. and ¾ in. stuff, the edges of the thicker pieces being rebated so as to cover those of the thinner ones. Thus the surface of the back is, on the inside, flush throughout, but on the outside, one piece projects beyond another. The two outside pieces next to the sides should of course be thick pieces. The ends of these uprights are nailed to the top rail A and the inner edge of the bottom, and the sides are nailed down to the thick pieces of the back on each side.

Lastly, a top is made of inch pine, flush with the thick pieces of the back behind, but projecting 1 in. over the sides and front. It is screwed on to A, B, F, and L from the inside. It may be pointed out that F and L are ledges screwed to the sides for this purpose, running from the top-rail B to the top-rail A. The sides are made in one piece throughout, and are cut out at the bottom, as shown at M. Pieces are then attached to the front at N and O, to give the appearance of dwarf legs, on which the chest of drawers seems to stand. A moulding is run round the top of the case in order to take off the harsh appearance of the sharp rectangular edge. Sometimes the bottom is moulded and projects slightly beyond the general plane of the front, and instead of dwarf legs or feet, as shown in the figure, the sides are not carried below the bottom, but blocks are screwed on to the bottom at each angle in which short turned legs or knobs are inserted. The fronts of the drawers should be made of inch wood, and the

Plate XVII ADJUSTING PLANE IRONS

[illegible] thin plan[illegible]
Adjustin[illegible] plane [illegible]

Plate XVIII PICTURE-FRAME MAKING



1 Cutting [illegible] mitre [illegible] Nailing [illegible]
[illegible]

sides and back of $\frac{5}{8}$ in. stuff, $\frac{1}{2}$ in. stuff, or $\frac{7}{16}$ in. being used for the bottom, which is run into grooves cut in the inner surface of the front and sides as already described in the section devoted to the construction of drawers. When finished, the chest of drawers, and indeed all articles of furniture made of pine, may be painted and grained, or stained and varnished, or French-polished.

Cupboards.—A cupboard may be fixed or movable, that is to say, it may consist of a recess in a room which is covered in by a frame and doors hung within the frame: or it may be made with sides, bottom, top, and back, like the case or frame of a chest of drawers, having doors in front. It is manifestly impossible, as it is also unnecessary, to describe all the different positions in which cupboards may be constructed, or all the different articles of furniture which partake of the nature of cupboards; we shall therefore confine our descriptions to the method of fitting up a recess by the side of a fireplace as a cupboard, and the mode of making a small portable cupboard, and of making and fixing the old-fashioned but useful corner cupboard.

Let us suppose, first of all, that we are about to make a cupboard in the recess of a room already finished. There is a skirting round the room which must not be cut away as we may desire to remove the cupboard at some time or other and to leave the recess and skirtings undamaged by our operations. Our first care is to make a frame with a door or doors hung within it. Part of the frame may be cut away so as to fit over the skirting and to abut against the surface of the wall, or a slip of wood may be nailed to the side of the cupboard so as to fill up the intervening space. It must be left to the option of the maker whether he will have a rail across the frame at the bottom; if not, the sides must be kept in place by nailing a thin slip of wood across them and leaving it until the frame is fixed. The frame being ready and the door hung within it, though removed temporarily until the frame is fixed, arrangements must now be made for fixing it. First, nail two slips of wood to the floor against the skirting, and to the wall at the required height fix ledges. On these ledges the top of the cupboard may be laid and fastened down. To this top the top rail of the frame is to be nailed, the bottom of each side butted against the skirting and secured to the floor by skew-nailing. When the frame and top are complete the doors may be re-hung. If the recess is to be

fitted up with shelves, ledges must be nailed to the wall on each side to support them.

If a dwarf cupboard is to be made, the same plan is to be followed, but in this case the top may be of $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. stuff., or if thinner stuff be used, an appearance of thickness should be given to it by nailing on a strip of wood or a moulding to the edge of the slab. The top should project beyond the surface of the frame and doors; but if a slip or moulding be nailed to it, the edge of the top may be flush with the frame, and the projection made by the slip or moulding which may be nailed to it.

Small Portable Cupboard.—We will now proceed to consider how a small portable cupboard may be made which, with various slight modifications, may be made available for a variety of purposes and situations. Such a cupboard is very closely allied to the sideboard, and may be easily adapted to do duty as such. It will be understood that this and all other articles of furniture which may be described in this chapter may be grained, or stained and varnished, or French-polished. The style in which the amateur may decide to finish his work must be left to himself.

The sides are made flush throughout from top to bottom, and to these the panels and frames which form the doors are hung. The back is made in precisely the same way as the back of a chest of drawers, and the top, when a simple top like that of a chest of drawers is used, is put on in a similar way. In some cases it may be convenient that the top of the cupboard should slope so that it may be used for a desk with a ledge at the back. To make the desk, ledges must be screwed to the side and a rail mortised into them in front against which the top of the cupboard may rest when closed. The sides of the cupboard may be carried high enough to form the sides of the desk, and a flat piece must be nailed across, to which the lid of the desk must be attached with hinges, but in this case allowance must be made for the projection of the desk beyond the cupboard front. If, on the other hand, it is not desired that a desk should be above the cupboard, the sides should be carried up square so that a drawer may be put at the top instead of a desk and a ledge carried round to prevent things from falling off, but in the case of the desk the ledge will be carried only as far as the beginning of the slope. Brackets at the sides form a useful addition to the cupboard, especially in a small room.

Construction of Three-cornered Cupboard.—The old-fashioned three-cornered cupboard for the corners of rooms is now very seldom seen except in old farmhouses and cottages. Its modern representative consists of three shelves decreasing in size from the lowest to the highest, set in side pieces which fit against the walls of the room and are ornamented with fretwork. In this form it is little more than a bracket in three tiers, and it is suitable for nothing else than a stand for china and other curiosities of value. There are many places, however, in which a corner cupboard shut in by a door, and thus rendered a receptacle in which articles can be kept under lock and key, will be found not only useful but appropriate, and for this reason some remarks are now added on its general construction and the method of fixing it.

For all practical purposes, the plan of the three-cornered cupboard given in Pl. L, Fig. 8, will be sufficient to show the amateur the general principles of construction of articles of this kind. A B and B C are the sides of the cupboard, which must be dovetailed together at right angles, so as to fit against the walls that meet and form the corner of the room. The common method of procedure is to bevel off the edges of these sides at an angle of 45°, and fit against them a frame shown by the double dotted lines A F and G C. To this frame the door F G is hung. Now it is clear that when a corner cupboard is made in this way its capacity for holding articles, such as cups, jars, etc., is very limited, the corners at F and G being almost useless. The holding capacity of the cupboard may be increased without increasing the size of the sides, by dovetailing or otherwise fixing sides as shown at A D and C E at right angles to the main sides A B, B C. The sides A D and D C will serve as the frame for the door which may be hung to either of these side pieces as may be most convenient. In the figure, the door D E is shown as being hung to C E by hinges as at E. Whichever way the cupboard may be made, there is no necessity for stops inside, as the edges of the shelves will furnish stops to stay the inward progress of the door. To receive the shelves, ledges as at F H and H G should be screwed to the interior of the sides A B and B C.

When the cupboard is made with a projecting front, as indicated by A D, E C, the corners at A and C are rendered useful. With regard to other details—which would appear in a drawing of the elevation, but which is not given, as the amateur will be capable of working this out on paper for himself—according to the first plan the top and bottom should be added to the sides

first of all, and the frame in which the door is hung made to cover the whole, and be flush with the outer surfaces of both top and bottom. According to the second plan, in which the cupboard is made of greater capacity, the bottom of the cupboard may be brought beyond the lines A D, D E, E C, as shown by the outer dotted line, and neatly rounded off in the form of a bead. The top, in this case, may also be nailed on over the door, but flush with it, and not going beyond it; and a ledge may be screwed firmly to the upper surface of the top, flush with the edge that appears over the door, in order to carry a neat moulding or crestboard, which will impart an appropriate finish to the top. This may be ornamented according to the taste of the maker.

To support the cupboard, ledges should be nailed to the wall in the same manner as for the support of the shelves within the cupboard at F H and H G, and to these a rail may be mortised, running from the outer end of one ledge to the outer end of the other, forming with them a skeleton shelf on which the cupboard may rest. To keep the top of the cupboard close against the wall, two pieces of iron may be screwed to the sides and a brass headed nail driven through the hole in the top of each iron.

The Wardrobe.—The wardrobe may be described as a combination of the cupboard and chest of drawers, as most wardrobes are made with a cupboard at top and a deep drawer below. It is not likely that the amateur will ever proceed so far in joinery as to construct a wardrobe; he will, in all probability, be content with fitting up a recess in a bedroom as a hanging closet; but for those who would like to try their hand at such a piece of work, details of the construction of a very useful wardrobe are given below.

The body of the wardrobe, must be made in two parts with the cornice above and the plinth below separate. Suitable proportions for such a wardrobe as this are 7 ft. high, including plinth and cornice, and 4 ft. 6 in. wide. Its depth should be 18 in., without the doors. Allowing 4 in. for the plinth and the same for the cornice, the size of the parts or carcases in which the wardrobe is made is 6 ft. 4 in. by 2 ft. 3 in. The back edge of the frame of each part must be rebated to allow of a ¾ in. framed back, or a back may be put in as already described for a chest of drawers. The sides of the frame should be made of 1¼ in. stuff, well planed down. In the part to the right hand is a hanging cupboard with

a rail for pins or hooks for clothes. At the bottom is a deep box for hats and bonnets. The front of this box is a fixture, and the top slides in and out. The part to the left hand is made to contain six trays above for clothes, etc., which pull in and out, and two drawers below, the lower drawer being of the same depth as the bonnet-box in the right-hand compartment. The trays run in grooves made in the sides of the compartment in which they are placed; they are 1 in. apart, and are about 6½ in. deep, with 3 in. fronts. They have very much the appearance of six small butlers' trays fitted in one above another. As there is the depth of 1 in. between the trays, the amateur will find it easier to screw ¾ in. ledges on to the sides of the compartment, on which the trays may run, instead of ploughing grooves in the sides of the compartment and making the bottom of each tray to fit the grooves. The drawers at the bottom are 8 in. and 10 in. in depth respectively, and as the depth of the lower drawer and hat-box correspond, the latter in the right-hand compartment must also be 10 in. deep.

When the two compartments are finished, the plinth is framed so that the compartments may drop within it, and a moulding placed round the top. The plinth must be made broader than the compartment to allow for the doors, which must open and shut just clear of the moulding and over a slip of wood which is nailed to the top edge of the plinth, *within* the moulding and flush with the top of it. When the compartments have been placed side by side of the plinth, two or three screws may be driven through the inner side of one compartment into the adjacent side of the other to keep them firmly together.

With regard to the doors for the compartments a frame is made to receive a circular headed panel. The wood used for the frame should be 1¼ in. thick when planed down, and the hanging style should be 4½ in. wide and the falling style 2½ in. wide. The doors are hung to the outer side of each compartment. The panels, if desired, may be filled with a mirror. In this case, a strong panel must be put in behind the glass. For the cornice a frame is made similar to the plinth but flush with the sides and projecting only in the front. A moulding is nailed on to the edge of the frame which drops slightly over the top of the compartments. The door is made to work clear of the moulding, the space between the moulding and the frame being filled up as in the plinth with a small piece of wood of the necessary thickness. If made of deal, the wardrobe should be stained and varnished or French polished.

Kitchen Dresser.—The amateur will not in all probability be called upon to make a kitchen dresser, but by way of providing additional accommodation of this kind he may desire to fit up a recess in a kitchen or scullery. To this end a brief description of the kitchen dresser and the way in which it is made may prove of use to some of our readers.

In the general construction of a kitchen dresser, a deal board about $1\frac{1}{2}$ in. thick is made to form the dresser board or principal shelf. This board is supported at either side by two solid ends which in their turn are framed into a plinth, consisting of a platform made of boards nailed on runners. The ends of the dresser are mortised into the outer runners on each side and the boards forming the platform are nailed to these and to two or more cross-pieces framed into longitudinal pieces of the same thickness at front and back. To the broad frame thus made it is desirable to form a back with match-boarding or with boards, put on as in the chest of drawers—that is to say, thick and thin boards in alternation, the edges of the thicker boards being rebated so as to fit over the thinner ones. A slip of wood must be nailed in front of the framing of the platform below, to conceal from view the space underneath. Along the front of the dresser a frame is inserted to receive two or three drawers, and under that part of the frame which divides any two of the drawers, whether they be two or three in number, it is desirable to put uprights, to help support the dresser top, and to prevent it from sagging in the middle from its own weight, which is often the case with large and long dressers. The framing on which the drawers run is made in precisely the same way as that which receives the two small top drawers in a chest of drawers. The space below the drawers may be closed with doors or left open, as may be thought desirable. When left open the platform is painted black, and constitutes a "pot-board" on which saucepans, kettles, etc., are placed when not in use.

On each side of the top, and on the inner part, two upright sides are mortised, and into these are mortised shelves, the lower shelf in every case being narrower than the one immediately above it. Ledges are nailed along the upper surface of these shelves and along the top to support plates and dishes, and hooks are screwed into the front edge on which jugs and cups are suspended.

The lowest shelf in the dresser, which is formed in reality by the inner part of the dresser-top, is reserved for cheese-plates; the shelf next above for pudding-plates, the next for dinner-plates

and the top shelf for large dishes. When soup-plates are frequently used, it is as well to have, if possible, an extra shelf. The dresser is finished with a cornice and moulding above. That it is desirable to make the sides of the dresser so that the higher a shelf is the further it projects, is manifest from the fact that the jugs which are placed on the hooks fixed to the higher shelves hang out clear of those on the shelves below, and can be easily reached and removed without touching any of those beneath them. The space behind the shelves may be filled with match boarding or left open, as may be desired; it is better, however, to fill up with match boarding, which, when painted can be washed when necessary while a coloured wall cannot be cleaned in this manner.

Bookshelves.—From drawers, wardrobes and dressers we may pass on to bookshelves which the amateur carpenter will be more likely to make for himself than any of the pieces of furniture previously dealt with. The shelves may be made of ordinary deal about ⅜ in. thick or the spruce boards of which egg-boxes are made, being both light and strong, will be found suitable for the purpose. Out of the wood forming an egg-box it is possible to make a small set of bookshelves with plinth and cornice which when cleaned up, stained and varnished, will betray no traces of its origin. We will begin by giving instructions for making a set of shelves of this kind and then proceed to others of more elaborate construction and superior finish.

First of all, four nice clean pieces of board must be selected for the top, bottom and sides and these must be nailed or dovetailed together as may best suit the amateur. The boards used in making egg-boxes are as a general rule thin and for this reason it will be better to dovetail the parts together. Before the tenons and mortises are glued up and otherwise secured, ledges must be screwed to the inner sides to support the ends of the shelves. The frame may then be put together, and the shelves, which must be flush with the edges of the frame, both in front and at the back, can be slipped into their places and secured with brads through the sides.

In order to do away with the thin and unsubstantial appearance presented by the edges of the sides and to hide the end of the side ledges, strips of wood about 1 in. in width are nailed to the edges of the sides in such a way that the inside edges are flush with those of the sides.

After this is done it will be as well to nail thick ledges of

wood to the outer surfaces of the top and bottom, to serve as foundations for the cornice and the plinth respectively. The cornice is formed of a piece in front, and two sidepieces. These parts project beyond the top of the shelves all round. Before the front piece is put on, a strip of leather should be nailed below it to its inner surface. This leather must be exactly as long as the distance between the inner edges of the strips on the sides, so as to work in and out freely between them; and when the shelves are completed strips of the same length should be nailed to the edges of the shelves. Finally, round the bottom, and having the upper edges flush with the surface of the bottom of the frame which forms the lowermost shelf, pieces of wood, bevelled on the upper edge, should be nailed to the ledges attached to the bottom so as to form the plinth, which may, if the amateur desires, have a half-inch bead bradded on round the bottom. If the board of the frame which forms the lowest shelf has not been brought out far enough to be flush with the slips, these slips being dropped into notches cut in the boards to receive them, the opening between the edge of the shelf and the top of the plinth must be filled up neatly and closely with a slip of wood of the proper size. The sides and front of the shelves may then be stained and varnished. The appearance of the shelves is much improved by the addition of two small brackets placed under the front of the cornice or crest-board so as to appear to support it.

In a similar manner a set of shelves without the cornice and plinth may be made to fix against the wall. In this case the shelves should be grooved into the sides and back and glued up and nailed. The sides may be stop-chamfered. These shelves are suitable for hanging in a recess, but it is advisable to make them the width of the recess or, if not, to fix brackets in the form of quarter circles on the sides in the same plane as each shelf. Upon these brackets china and other ornaments of a suitable height may be placed.

These bookshelves may, with a little contrivance, be adapted to form shelves on the top of a dwarf cupboard. In the first kind the plinth should be omitted altogether and the bottom of the framing that holds the shelves be allowed to rest on the top of the cupboard or the sides be extended downwards and mortised into the boards forming the top of the cupboard. In the second example, the sides may be extended downwards, and also mortised into the top of the cupboard. In each of these the most appropriate way of extending the sides is to carry them

downwards in the form of a bold bracket sweeping outwards, and wider at the bottom than at the top where the shelves commence. The extension thus made may be pierced with fretwork or carved in low relief, in accordance with the general character of the ornamentation of the shelves.

We will now examine a simple but effectual method of making bookcases or bookshelves that will be found particularly useful to the amateur, inasmuch as the shelves can be added to or decreased in number at pleasure, and adapted to any kind of room or recess, no matter what its size may be. Being made in deal, stained and varnished or French-polished, the cost is but little for shelves that cover a considerable expanse of wall; and as their construction is but very simple, they are such that any amateur may make for himself, even though he be not able to use his tools as well as he could wish.

The endpieces and indeed all the standards that divide the bookshelves into compartments should be made of good straight grained pine, ¾ in. in thickness after it has been planed down, and if the shelves be large and cover a considerable area of wall, it will be as well to have them 1 in. in thickness. There must be *two* endpieces, but the standards between these may be as few or as many as may be necessary. In a long extent of shelving the distance between each pair of standards should not be less than 2 ft. or more than 3 ft. First taking the structure of an endpiece, which may be of any height, though 6 ft. will be found convenient, one side must of course be left perfectly plain, but on the other and inner side a stout ledge about 1 in. square should be screwed and strips along both edges, notched for the reception of slides on which the ends of the shelves may rest. The standards and the other endpiece are made of precisely the same size, only in the second and opposite endpiece the ledges and notched strips must be screwed on to the reverse side, so that the parts of the ends thus prepared may be inwards and facing each other when the ends and standards are placed in position. In the standards the ledges and notched strips are attached on both sides instead of on one side only as in the endpieces. When the standards and endpieces have been placed in position at such distances from each other as may have been previously determined, a board is laid along the top from end to end, and nailed or screwed—screwing is better in case of removals and taking the bookcase to pieces at any time—to all the uprights. Additional firmness is obtained by means of a narrow board which is screwed to the endpieces,

and standards all along the front. To this a moulding is attached above, and the cornice consisting of this moulding and the facia is apparently supported by carved brackets attached to the endpieces and standards. Along the bottom a board about 15 in. in width, is attached to the endpieces and along the entire length; and for the sake of rendering the bookcase substantial in appearance, another narrower board is screwed on in front; the two boards, with the moulding or bead which is placed along the top, forming a bold and handsome looking plinth to the whole bookcase. The chief use of the moulding is to mask the outer edge of the bottom board which—as, indeed, are all the other shelves—is cut to form a shelf or platform to receive the lowest row of books, which will comprise the largest and heaviest among them. As this shelf can be removed at pleasure when all the books upon it are taken out, the open space below it affords a convenient place for stowing away unbound periodicals, rolls of maps and engravings, and the various papers which are usually put in the cupboards of the bookcase when it is made with cupboards below and shelves above. The shelves are finished in front with scalloped strips of American leather-cloth, or embossed edging, which may be let into the under part of the shelf close to the front edge with a tongue and groove or nailed along the edge with gilt-headed nails or studs.

It will be obvious that the standards and ends will serve in any case, and that when it is necessary to extend the bookcase and add to its length, to accommodate an increasing stock of books, all that is necessary is to carry one end further on, to interpose a new standard, and to have new boards for the top, the facia, and the plinth. If it is needful to curtail the length of the bookcase, it is merely necessary to take out a standard and reduce the boards that have just been named to the required extent. When, as may be the case in moving from one house to another, it is necessary to reduce or extend the length of the bookcase by a few inches only, it may be managed by bringing the standards a little closer together and shortening the shelves; or by increasing the distance between any pair of standards—the central compartment or compartments being the most suitable—and having new shelves for the space or spaces thus extended. It is almost needless to remark that it is always prudent to preserve old facias, plinth-boards, and shelves that have been replaced by others, as they may be found useful on another occasion. If it is desired to have glass doors to a bookcase of this kind, the notched strips should be placed farther in, and the doors made so as to be hung

to the ends or standards, their outer surface being flush with the outer part or edges of the ends and standards. When the bookcase is a fixture, doors are desirable for the purpose of keeping out dust, but when *elasticity* in the bookcase is desirable it should be made without doors as described.

Expanding Bookcases.—An American writer has suggested a very simple and ingenious method of making a bookcase on the expanding principle, and doing away with the necessity of packing and unpacking books on removal from one house to another. The plan, which is as follows, is well worth the attention of the amateur.

"The cheapest," the inventor says, "is also in some respects the best bookcase. This is a box or case of boxes, of indeterminate number. The box is about 4 ft. long and 20 in. high, inside measurement. A shelf runs from end to end, dividing it into two sections, each, therefore, being about 9½ in. high. Three or four of these boxes, placed one above the other, make a case 5 to 7 feet high. An unostentatious base-board (plinth) below, and a moulding (cornice) above, will help to make it ornamental. If the two upper boxes are made a little narrower, and not quite so high, the bookcase presents a graduated appearance, which is, perhaps, an advantage. If you have occasion to move, you have only to turn your boxes over on the back, without even taking the books out, stuff paper or cloth about them, screw a board on the upper surface and they are safe." To the above description we need only add that the plinth should be made in the same manner as that which has been described for the wardrobe, but higher, in order to keep the lowest row of books out of the way of dust from the floor. The cornice also should be made in a separate piece and drop over the topmost box. It is advisable, too, that some method should be adopted of connecting the boxes when piled one above another. This may easily be effected by running a bead from top to bottom at the back or sides. This of course must be unscrewed before the boxes are taken down for removal. As a finish to the shelves, a strip of scalloped leather edging should be nailed on.

The amateur carpenter, who is fond of books and can manage to appropriate a small room to himself as a sanctum or study, can now see how easily he may make for himself any article of furniture within it except his chair which he will do well to purchase.

From what has been written in the foregoing pages the amateur

will doubtless find the way to make other useful things similar in principles of construction which, by reason of this similarity, need no mention in this chapter.

CHAPTER X

HOUSEHOLD FIXTURES

APART from the actual construction of various articles of furniture, the amateur mechanic will always find scope for his energies in connexion with the numerous fixtures, whether temporary or otherwise, which occupy a place in every household and, in the present chapter, we may proceed to deal with these

Blinds, Blind Roller and Fittings.—The manner in which a blind roller may be made has been described in a previous chapter (see p. 223). The present consideration is the fixing of the roller in position. The roller is usually supported on a couple of brackets, but how and where these brackets are to be fixed and the kind and form of bracket which it will be convenient to use depend largely upon circumstances. Assuming that the window is an ordinary window, that is to say, a frame finished on the outside edge of the inner face with a moulding, the proper places for the bracket will be just within the moulding. To ensure accuracy in ascertaining the length of the roller, it will be better for the amateur to screw up his brackets first, and then measure off the extreme length between them, allowing when cutting the roller not less than ¼ in., and not more than ½ in., so that the roller may work freely when suspended by means of the pins at either end on the brackets. In the bracket for the left-hand end a small hole is made for the reception of the pin, and in putting up the roller the pin at this end is first put into the hole in the left-hand bracket, and then the pin at the other end is lifted over the right-hand bracket until it is high enough to drop into the hook formed in it. When put in its place the roller should be turned quickly with the hand to ascertain if it works easily. The brackets are fixed with screws.

Sometimes it is necessary to hang the blind *within* the window-frame; when this is done the pins of the roller are supported on small brass projections semi-globular in shape, screwed on to flat pieces of wood, just wide enough to fit the groove between the outer board of the frame and the parting slip, within which the *lower* sash-frame works up and down.

In measuring the material required for the blind, the length of the window should be first taken and 6 inches added so as to allow for a full turn to be kept on the roller and also for the fold at the bottom in which the lath is to be sewn. The width should be not less than 1 in. short of the length of the roller. In some cases it may be necessary to hem the sides of the blind, but, if possible, material of the exact width required should be obtained, as when rolled up the hemmed edges may easily be too thick for the depth of the bracket. The cutting of the stuff should be done by laying the blind on a long table or bench and using a sharp knife with a wood straight-edge as a guide. Great care should be taken to get the ends perfectly square with the sides.

When the brackets are fixed and the roller works easily and truly within them, the next thing is to nail the blind itself to the roller. Before doing this, slip the upper end of the fabric over the roller, moving it one way or the other as may be necessary until the blind hangs straight down from the roller, inclining neither to one side nor to the other. Unless this precaution be taken the chances are that the blind will be crooked, and not roll up and down fairly within the plate or disc on the left hand end and the pulley on the other end. A good plan to adopt before nailing the blind to the roller is to tack a piece of tape along the top edge. This adds considerably to its strength and prevents the material from being torn from the roller when the blind suddenly runs down. The rack and pulley (see Pl. XIX, Fig 5) to carry the blind-cord must now be screwed on to the window-frame, and the cord itself passed through the *lower* part of the pulley, cut to the proper length, and sewn. There is some little art even in sewing the ends of a piece of blind-cord together. The ends should be lapped one over the other, and sewn through and through. When firmly connected in this way the over-lapping ends should be tightly overlaid or bound over with thread all along the joint, which will be found to be a strong one that will work easily over the pulley of the roller and the pulley of the rack. To complete the fixing of the blind all that is necessary is to lift the pulley end of the roller out of its place, slip the cord over it, re-insert the pin in the bracket and then slip the catch and pulley down the rack, taking care not to strain the cord too much, but merely to tighten it sufficiently to work the blind up and down.

The method described above is that of fixing the ordinary form of house blinds. In recent years, however, several patent

appliances for use in connexion with blinds have been introduced and some mention may be made of these.

In one form is used a flanged roller end of metal, around which a cord is wound the reverse way to the blind, so that when the cord is pulled and unwound the blind is rolled up. Similarly, when the blind is pulled down by means of a cord attached to the centre of the bottom lath the blind cord is again wound round the flange. When the blind is pulled up the cord is generally secured to a patent cleat hook. Any unsightliness in the appearance of the single cord hanging from the blind lath is avoided by enclosing the knot at the end in a box wood acorn cord holder.

The objection to these roller ends is that they lessen the length of roller available for the blind, and their use would not in some cases admit of the blind being sufficiently wide to cover the window.

In the improved pattern of the flanged roller end, shown in Pl. XIX., Fig. 4, the blind cord passes through the loop of a lever, the other end of which engages in the teeth of a ratchet wheel and retains the blind at any desired height without the necessity of fastening the cord to a cleat. A similar fitting is used in connexion with spring blind rollers. The spring rollers are very convenient and quickly operated, but they are liable to get out of order, and as the mechanism is somewhat complicated the amateur would experience some difficulty in fitting them and making them work in the first place and in putting them to rights when they need repair. Briefly, however, they consist of a case or barrel generally of steel, but sometimes of wood, enclosing an iron bar upon which is wound a long helical spring. The ends of the bar are fixed and the outer case to which the blind is fitted revolves in such a way that the drawing down of the blind winds up the coil of the spring. When the blind is released, the spring is sufficiently powerful in its action of uncoiling to draw up the blind.

Venetian Blinds.—This form of blind undoubtedly presents a nice appearance and may be used to modify the light within a room far better than the common blind, as the degree of light to be admitted can be regulated at pleasure by bringing the laths of which the blinds are composed closer together or farther apart by means of a cord connected with the topmost lath for this purpose. Venetian blind-making may be said to be a trade in itself, or at all events a special branch of carpentry, as in all

parts there are found men who seldom do any other kind of work. As a general rule the amateur will buy his Venetian blinds ready made and merely fix them up himself and this he may do without difficulty.

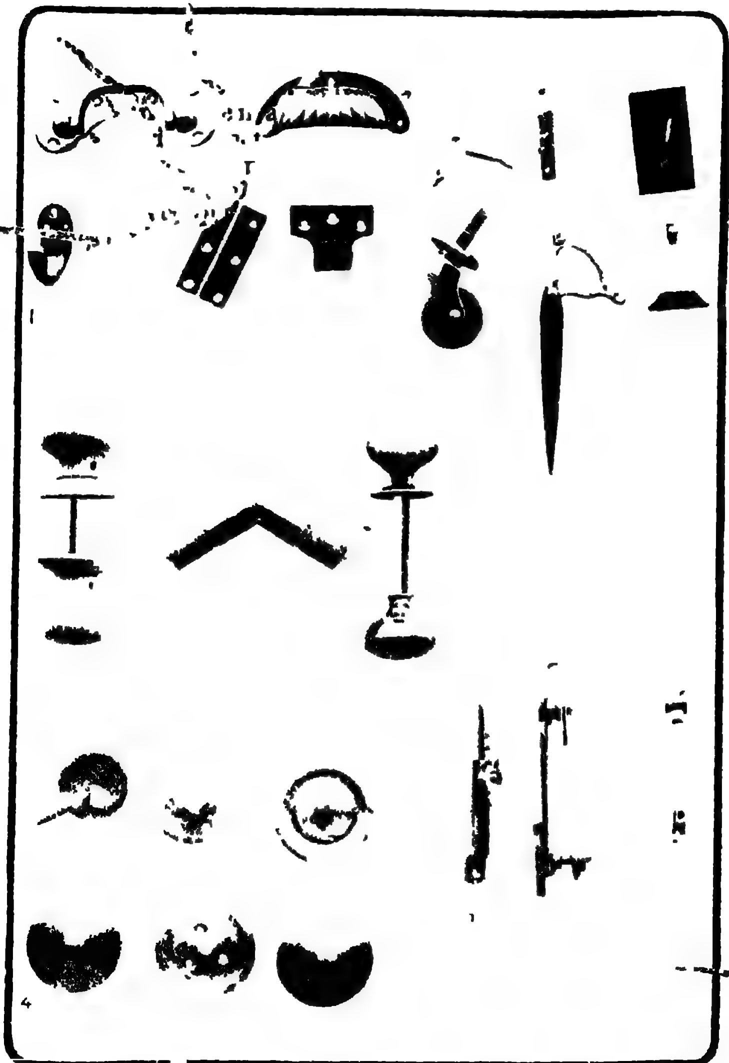
If, however, he is determined to make these blinds for himself, the best thing he can do is first to buy an old Venetian blind of a dealer in second-hand goods, and study its construction thoroughly; taking it to pieces, putting it together again, and repairing it and getting it into working order. Secondly, unless he have plenty of time on his hands, and can devote enough of it to accomplishing the task of sawing his own laths, he had better, when about to make a new blind, purchase his laths already sawn and planed. He has then nothing more to do than to cut them into pieces of the necessary length and plane them up.

Roughly described, the Venetian blind may be said to consist of a number of laths placed in two or more ladder-like cradles, each formed of two broad tapes with transverse tapes between them, like the spokes of a ladder, to sustain the laths. The ends of these tapes are secured at top and bottom to two thicker laths, and by means of a cord, the ends of which are nailed to the topmost thick lath, the laths may be opened or closed at pleasure. The transverse tapes are narrow and are sewn to the broad vertical tapes alternately, one being brought to one edge and the next in order to the other. The laths have freedom of movement to some extent and rest on these tapes. The cord by means of which the blind is operated is attached to the top thick lath, one end to one side and the other to the other side. When, by pulling the cord, the front edge of the top lath is depressed and the back edge raised, the motion is communicated to the tapes and thence to the intermediate thin laths and the bottom thick lath, all of which assume the same position. Similarly, if the back edge of the top lath be lowered then a corresponding movement will be given to the other laths. According to the extent to which the cord is pulled, the position of the laths may be altered from a level or horizontal position to one that is almost vertical, and the openings between the laths increased or diminished.

This, however, does not explain the means by which the Venetian blind can be raised or lowered; it only describes the construction of the blind itself and the manner in which the laths are sustained and put together; the means of raising and lowering the blind are altogether independent of this. For the latter

purpose, holes are cut in each of the laths just midway in the space covered by the vertical tapes, and a cord is passed through these holes, the lower end being attached to the bottom thick lath. The ordinary manner of doing this is to make a hole through the bottom lath, pass the cord through it and make a knot at the end so that it may not be withdrawn. When there are only two tapes arranged vertically, or, to speak more strictly, two pairs of tapes, two cords are used; but if the blind be wide, and three pairs of tapes be used, three cords will be required. The cords are passed up through the holes in the laths, the tapes falling alternately, one on one side of the cord, and the next on the other side. In a thick board the same length as the width of the blind, two slots, corresponding to the position of the tapes and cords, are cut and in these slots small pulleys, shown in Pl. XIX, Fig. 5, are fixed. A third slot is also cut at one end wide enough to receive two pulleys, or even three, if necessary. This board is known as the pulley head. The blind is attached to the pulley head by means of short tapes or bands passing over rollers let into the board, and just long enough to allow the topmost thick lath to be turned either way without coming in contact with the lower face of the board; the cords are then passed over the pulleys and, after running along the top of the board are brought out over the end pulleys and knotted together. Of course it will be readily seen that when the blind is down, by pulling these cords it can be raised; and, *vice versâ*, by slackening the cords it can be lowered. The board is attached to the upper part of the window-frame by screws, but care must be taken not to turn the screws in too tightly lest the cords be pinched between the board and the framing of the window, and prevented from working properly. When the blind is raised the cord is secured by passing it round a cleat screwed to the wood-work of the window-frame in some convenient position. An alternative method of fixing the pulley head is to use a right-angled iron bracket which is screwed to the sash frame and the under side of the pulley head. It may answer the amateur's purpose to cut down old blinds to fit smaller windows, or to re-arrange the laths; but, unless he has a great deal of time at his disposal, it will hardly *pay*, as the phrase goes, to make new ones. Of course, before the blind is put together and fixed in the position it is to occupy the laths and board must be painted, or they may be simply stained and varnished. The stained laths, however, are not so pleasing in appearance, either within or without the house, as those that are

Plate XIX HOUSEHOLD IRONMONGERY



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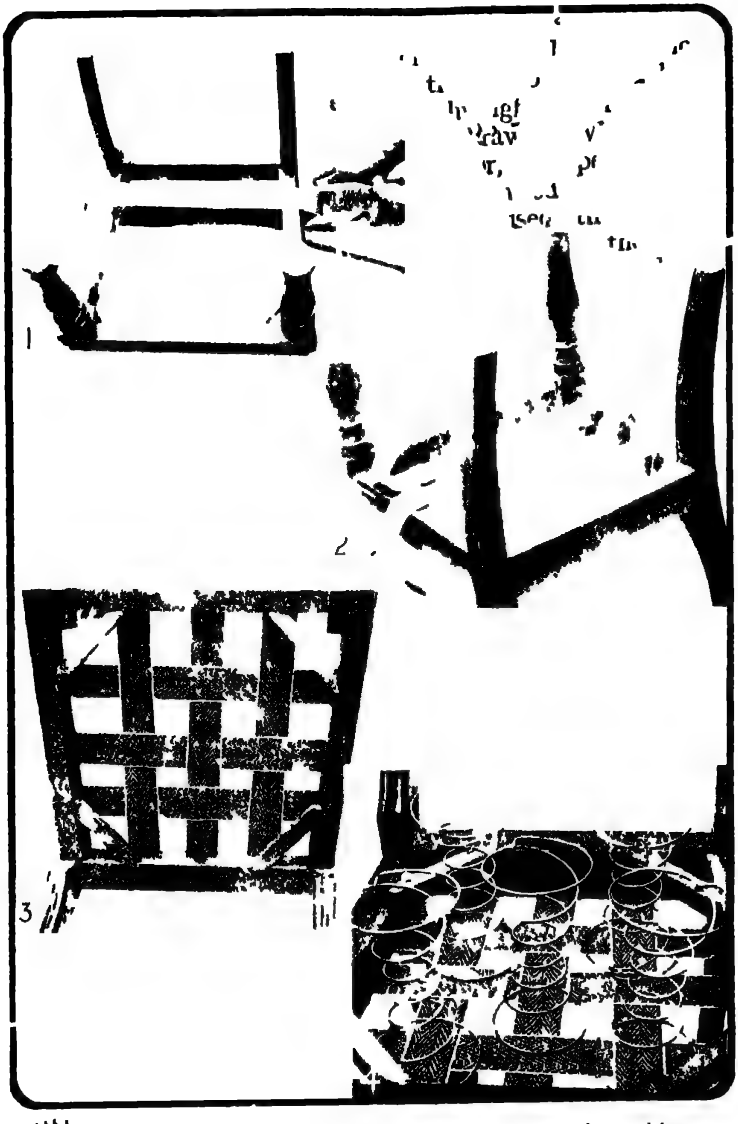

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painted For instructions with regard to painting Venetian blinds see p. 455

External Sunshades.—External sunshades for windows are made in some measure in accordance with the mode adopted for raising and lowering Venetian blinds. First of all, a screen of thin wood, which serves as a protection for the blind when drawn up, is fixed within the reveals of the windows. Two rods are then made, either of wood or iron, and fixed one on either side of the window. A piece of iron bent so as to form three sides of a rectangle, is fitted with rings at the end, so as to work up and down on the rods. Some strong material, usually striped, is then made up to form the shade with a straight piece in front and triangular sides. Small brass rings are then sewn to the front piece, in the centre and at the sides, and larger rings are sewn to the straight sides of the triangular pieces to attach the blind to the rods and work up and down at pleasure. Strings are then fastened to the iron and passed up through the rings. These cords pass over pulleys in a board fitted within the reveal of the window at the top, in the same manner as in the Venetian blind, and by these cords the blind can be raised or lowered at pleasure. When the cords are pulled the iron frame is first raised into an upright position, and then is pulled up—frame, blind, and all—within the boarding forming the screen.

Fixing Curtain Poles.—The method of making a wooden curtain pole has already been described. Very handsome curtain or cornice poles of polished brass, may now be obtained in great variety at very moderate prices, and in some circumstances, the amateur may prefer such poles to the wood variety. In either case the manner of fixing the pole is much the same. The brackets, usually of brass, are screwed to the exterior member of the moulding surrounding the window. One end is removed and the rings are put on the pole, after which the end is put on again. The pole is next lifted on to the brackets, care being taken to put one ring, on either side, *outside* the bracket to keep the outer edge of each curtain in its place when they are drawn together. The pole is next prevented from being moved out of its place by turning the rose which is screwed to the front of the bracket, the end of the screw being forced against, and sometimes into, the pole. It need not, however, be screwed in so tightly as to do any damage to the pole.

The difficulty to which reference has been made with regard to fitting moulded wood curtain poles to bay windows is removed

in the case of brass poles, by the use of the cornice pole joints shown in Pl. XIX, Fig. 3. These patent joints, which are of polished brass and fitted with wood joint plugs, may be adapted to any bend of the window and are very easy to fix.

Cornices for Curtains.—Cornices may be straight or moulded. When perfectly straight, as for a window in the side of a room in the ordinary way, they must be returned, that is to say, turned at each end, so as to form with the front piece, a sort of box.

To make and fit up a straight cornice, a rectangular piece of wood is first taken to form the top. To this piece of board another piece to form the front, and two others to form the sides or ends, must be attached. The ends may be dovetailed to the front, and indeed ought to be, if neat and strong work is desired. By the aid of a centre-bit and keyhole-saw, the lower edge of the cornice may be given a lighter appearance somewhat after the style of bold fretwork or scroll work. Round the top a moulding should be nailed, and this should be neatly mitred together at the corners. To support the cornice nothing more is necessary than to screw two iron brackets to the moulding of the window frame. The projecting arm of the bracket must of course be screwed to the board round which the cornice is nailed to prevent it from being accidentally dislodged. To take the curtains, two strong hooks may be screwed into the sides of the cornice and a slender iron bar supported on them by holes in the ends.

To make a cornice to fit a bay-window, much the same procedure should be adopted. As the various joints used in carpentry have been fully described and explained in the earlier part of this work it will be unnecessary to do more than indicate the kind of joint to be made. In all simple joinery of this description the ordinary dovetail joint is all that is required.

In making a moulded cornice, the first thing to be done is to get an accurate model of the angles of the bay by screwing three slips of wood together, and from this model the piece of board may be made to form the top of the cornice. Along the outer edges of the board, pieces of wood must be attached at right angles to it, and jointed together at the angles. The lower edge of the united boards may be ornamented after the manner of a crest-board, and a piece of moulding nailed round the top as a finish. The chief difficulty in the joinery will be the connexion of the several pieces of wood at the angles. With these exceptions the method of making the moulded cornice is the same as that which must be followed in making the straight cornice: it

is with the arrangement of the iron rods within that we have most to do here ; that is to say, to show how the curtains may be drawn together, and the rings passed easily over the angle.

This may be done in various ways. One method consists in fixing a bar of iron, with holes at the ends which fit on to hooks screwed into the top board of the cornice. This bar sustains one curtain, and another bar similarly supports the other curtain. The rings will pass easily over the wide angle formed by the iron. The diameter of the rings used should be at least twice or three times the diameter of the bar, so that they may run easily along it from end to end. The close junction of the edges of the curtains is effected by the overlapping of the bars, which admits of the passing of the edge of one curtain over the other. Another plan is to obtain a piece of slotted brass tubing. This tubing is furnished with flanges or projecting pieces, by which it may be screwed to the top board of the cornice. A cylindrical piece of metal forming a sort of button is slipped into the groove. This button will slip easily along the tube from one end to the other. About a dozen are necessary for each curtain. A shank projects from the bottom of the button, which is pierced for the reception of the curtain hook. This brass tubing may be had in one single piece, but if it is desired that the curtains should lap one over the other when drawn close, it will be better to have it in two pieces.

Curtains, whether of light or heavy materials, are drawn together more readily by cords than by the hand. A great deal of pulling and dragging is often required to bring curtains together, and this, if the curtains be closed as a regular thing every evening, tends to damage and soil them. By a very simple arrangement of cords and pulleys curtains may be drawn and withdrawn at pleasure. The cords by which this is effected will hang behind one of the curtains at one side of the window after the manner of the cords of a Venetian blind. It will be understood that such an arrangement can be carried out far more easily when the curtains hang from a straight cornice than from one moulded to the shape of a bay window.

Brackets and Shelves.—The simplest form of bracket is simply a piece of iron bent in such a manner that the two arms of which it is formed are at right angles to each other. When bent in this way the bracket is often called an angle iron, and used for affording support and strength to wooden framing in which one part is placed at right angles to another. Brackets of this description, with arms ranging in length from 4 in. to

6 in. are often used to support narrow shelves in greenhouses, sheds, etc. For this purpose they are made in the simplest and roughest form of plain iron pierced with holes for screws, so that one arm may be screwed to the woodwork, whatever it may be, at the back, and the other arm to the ledge or shelf. A better kind of bracket of this description is made of iron with a projecting rib on either side, so that the head of the screw sinks into the groove between the ribs; these are either galvanized or japanned. This kind of bracket being made in iron will support a considerable weight without giving way, but it is clear that the longer the arm is made the less will be its sustaining power.

Bracket with Strut.—Means must therefore be devised to impart rigidity to the longer armed bracket, and this is accomplished by attaching an iron strut to the interior of the bracket. This strut is strongly riveted to the arms. A much heavier load may now be placed on than before the strut was attached to the bracket, for the wall now helps to support the weight, while before it was the arm alone that offered any resistance to the downward pressure. In some forms of brackets, ornamental scroll-work answers the same purpose as the simple strut. In this kind the arms are made much wider than in the ordinary metal bracket, so that holes for screws may be made in the flanges that project on either side of the ornamental work.

Wooden Brackets.—Failing iron brackets, wooden substitutes sufficiently strong for all ordinary purposes may easily be made To an upright of any suitable length and thickness, the horizontal piece forming the top must be connected by a tenon let into a mortise just half the width of the pieces, which must be of the same width and thickness. The ends of the strut must be cut, and let into notches for their reception, one in the upright, and the other in the horizontal piece. These notches need not be more than ½ in. deep in the deepest part. The best way to cut a strut is first to make the notches in the upright and the horizontal, and then, having connected these two pieces by the mortise and tenon joint made for this purpose, to lay them on the piece of wood intended for the strut, placed, of course, exactly in the position it is intended to occupy, and then mark off the angles at which the ends of the strut are to be cut, with a scribe or lead pencil. A wooden peg should be used to fasten the mortise and tenon joint, but the ends of the strut may be secured in their places by screws.

If the bracket is to be fixed against woodwork, three or four screws of sufficient length, passed through the upright—one at

the top, another at the bottom, and one or two in the middle—will be sufficient; but if it is to be fixed against a brick wall, the wall must be plugged by driving pieces of wood into the wall between the bricks in the most convenient positions, to afford holding for the nails which must be driven through the upright and which would not hold in the brickwork. The method of plugging a wall will be described later in connexion with the fixing of shelves.

Shelf brackets of a more ornamental appearance may be made by cutting them out in the solid from a piece of board and curving to the front. Such brackets may be further ornamented with piercings or fretwork. But as this work has already been sufficiently dealt with in the chapter on fret-cutting it will not be necessary to enter further into details respecting it.

In making a bracket for attachment to a garden wall as a support for a flower-pot, a broad piece of wood, say 4 in., at least, in width, should be fixed to the back of the bracket and the shelf above it, and two holes made in it by which it can be suspended on nails driven into the wall. In this case, it will not be necessary to nail the lower part of the bracket to the wall, as the arms, being secured, will keep it in position.

The shelves which rest upon the brackets should be cut to the required length and width, and the top surfaces and edges of the board planed up before it is fixed. If the shelf is high, and the under part is visible, that also should be planed.

Shelf in Recess.—The amateur may often find it desirable to fix a shelf in a recess or in the corner of a room or passage. The first thing to be done is to determine the height of the shelf. The shelf will be in all probability an inch thick, or very nearly so, when planed up, so that if the surface is to be 3 ft. above the floor level, marks must be made on the wall just 2 ft. 11 in. above the surface of the floor. The amateur will find that it is not advisable to work by the flooring, since this is not always level. As soon, therefore, as the marks have been made a straight-edge must be applied to them and the correctness or otherwise of the marks tested by means of a spirit-level. The method of using the straight-edge and spirit-level for this purpose has already been explained (p. 76). When the marks have been accurately adjusted by the aid of the level, ledges must be nailed to the wall. On these ledges the shelf may be dropped, and fastened down with screws or nails. Ledges for the support of shelves of this kind should be 1 in. thick and 2 in. wide. Sometimes, especially

where very neat work is required, the ledges are made of two slips of wood; in this case the inner piece is nailed to the wall, and the outer piece screwed on to it. The heads of the screws may then be concealed with putty, or a hole may be made into which the screw may be sunk flush with the bottom, and afterwards plugged (see p. 93).

The shelf should be cut to fit exactly into the recess, and scribed round so as to fit closely and accurately against the wall. In some cases, the wall at the back having been badly plastered will be irregular in form. If this is so, the shelf should be made a little deeper than is absolutely necessary, and when all is ready for fixing, should be pressed against the back of the recess, until the straight inner edge touches it where it will. Measure the breadth of the space between the shelf and the wall, where it is widest with a pair of iron compasses. Set the legs that they may not shift their position, and then, keeping the point of one leg against the wall along the line, press the point of the other leg on the surface of the shelf. As the points of the compasses preserve their relative distance throughout, a line similar in every respect to the configuration of the wall is traced on the upper surface of the shelf, and when the board has been cut to this line, having been cut away with keyhole-saw or chisel, it will be found that it may be pushed home to the wall, and will fit tightly against it. If desired, the outer edge of the shelf may be kept level with the chimney breast, and a piece of wood or moulding may be screwed on to the edge deep enough to conceal the ends of the ledges.

Corner-brackets.—It will be sometimes found convenient to fix a bracket in an angle of a recess or in a corner outside the door of a bedroom. A right-angled bracket with a circular sweep in front may be fixed by nailing short ledges to the faces of the walls forming the corner; if the bracket be a large one the ends of the ledges may be connected by a third piece of wood, so as to form a triangular framework which will afford a firm support for the shelf. In houses and others which are not fitted with gas, corner-brackets will be found useful as shelves whereon to place a lamp; in other circumstances they may be made available, when placed in the angles of recesses, for vases and other small ornaments.

The Bracket-table or Shelf.—The bracket-table, with a hinged flap, is suitable for a small hall or passage or even as a temporary table at a window or as an occasional sideboard in a small room. With regard to dimensions, a convenient size will be generally

24 in. to 30 in. by 18 in., but much will, of course, depend upon circumstances. In putting up such a fixture, the first step should be to make the flap or shelf which is to be attached to a rail, which in turn must be fixed to the wall, the attachment to the rail being made by means of hinges. The shelf should be made about 2½ in. less than the width desired for the table, the entire width being made up by the rail. The rail may be from 2 in. to 2½ in. wide, but its width must depend very much on the thickness of the skirting-board below, for reasons that will be apparent presently. When all the separate parts are finished the rail must be fastened to the wall behind, and rendered immovable. Next a bracket must be made, similar in construction to that already described. The ends of the upright must take the form of circular pegs projecting for about ¾ in. to fit into holes made—one in the rail and the other in a wooden socket screwed to the floor close to the wall. This socket, when the pegs at the ends are inserted in the holes cut to receive them, is screwed firmly to the skirting. The hole in the rail for the top of the upright support must be the same distance from the face of the wall as the hole in the socket. The rounded ends of the upright must, when all the parts are ready, be slipped into their places, and the rail and the support at the bottom screwed or fastened—the one to the wall, and the other to the skirting-board. It will then be impossible to pull the bracket out of its place, the only motion it can have being from side to side as it turns on its ends or pivots. When the flap, which is attached to the rail by hinges, is let down, the bracket folds away completely under the rail, but when the flap is raised, the bracket must be pulled out until it is at right angles to the wall behind. The table, flap, and fittings may be made of mahogany or of nicely grained red deal, stained as the fancy of the maker may dictate, and French polished. The edge of the flap should be neatly moulded, and the moulding should be carried on to the rail on either side for the sake of uniformity. In small houses and small rooms few things will be found more convenient than these bracket-tables.

Plugging a Wall.—In fixing brackets or ledges to serve as supports for shelves, it will frequently be found necessary to drill or cut a hole in the wall for the insertion of a wooden plug into which nails or screws can afterwards be driven. If the plug is to be inserted in the joints of brick or stonework, it will be only necessary to clear out sufficient mortar or cement to admit the plug, but in other places a hole of the required size

must be drilled to the depth of 2 in. or $2\frac{1}{2}$ in., in the brick or stone. The plug, which should be no larger than is absolutely necessary to furnish a hold for the nail or screw to be used, may vary from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. in diameter. Larger plugs are less effective, as they do not expand within the hole when the screw is forced in, and further, they are liable to work loose in course of time through the shrinkage of the wood. The piece of wood from which the plug is to be made should be about 3 in. long, 2 in. wide and $\frac{3}{4}$ in. thick. The opposite corners should be cut away with a chisel, so as to give a kind of twist to the entering end of the plug. There is a considerable divergence of opinion as to whether this plug possesses advantages over one with the sides left parallel throughout its whole length, but there is probably little to choose between them. For use with round holes, the plug should be made so as to fill the space into which it is driven as completely as possible. As in the case of dowel-pins (see p. 94) the ends should not be tapered, but only slightly rounded so as to facilitate their entry. The patent expanding wood plugs recently introduced, are a great improvement upon the ordinary form. These plugs may be obtained in various useful sizes, and their cost is very small. When a plug has been driven as tightly as possible into the hole prepared for it, the end should be sawn off level with the face of the wall.

Mantelshelf.—It will be understood that in a work of this description it is not possible to deal with everything that partakes of the nature of a shelf. For example, there is no necessity to speak particularly of an ornamental shelf covered with cloth or velvet, to be placed on a narrow or old-fashioned mantelpiece; for with the instructions already given the amateur will be at no loss as to the manner in which he should prepare the board and how to mould it in sweeping curves in front to suit his fancy, how to cover it with such material as may be deemed most suitable, to surround it with fringe of silk or wool attached to the edge of the board in front and at the sides by gilt-headed nails made for the purpose, and, finally, to fix it to the wall by means of small metal plates with holes in them to admit of the passage of brass-headed nails by which they are held to the wall. The plates are of course screwed to the back of the shelf, and the holes appear above it.

The gilt nails to which reference is made above are sold at the ironmongers, and are also used for fastening strips of leather to

the edges of bookshelves. The simplest and cheapest nails of this description are the small round-headed chair nails, the larger and more ornamental nails are of ormolu, gilt, and washable, and may be obtained in various sizes and patterns; a nail consisting of a white head, something like a conical bullet, but much smaller, attached to an iron spike, is also sold for this purpose.

Hat-rails.—Rails with pegs attached for hats, clothes, etc., are always wanted in a house, and when the amateur can use his tools, any special want of this kind may be speedily provided for. Rails may be fixed to walls by means of nails or to woodwork by screws; and they may be suspended by means of brass rings, somewhat stronger than those used for pictures. A rail should never be fixed across the inside of the door of a room, nor should nails be driven into the styles of any door, or hooks screwed on to them, for hanging clothes; for the weight of the clothes has a tendency to drag the door out of place, and prevent it from shutting closely against the stops as it should do.

A rail for the purposes above mentioned is simply a piece of wood from ½ in. to ¾ in. thick, and from 3 in. to 3½ in. wide, and as long as may be necessary. The face or front, sides and ends must be nicely planed up, and the *arris*, or sharp edge must be chamfered or taken off with the plane, or rounded with a beading plane. There are a great variety of metal hooks single and double, made in iron, brass, and bronze, or metal coloured to imitate bronze. Brass hooks are often furnished with porcelain knobs, but the bronze hooks are neater, cheaper, and more serviceable. In Pl. XIX., Fig. 1, is shown a useful kind of single hook for hanging clothes.

Picture-rails.—Most modern houses are provided with wood rails or mouldings fixed round the walls a short distance below the ceiling or cornice, from which pictures may be hung in any desired position on the wall without driving in large nails as was formerly necessary. These mouldings, which are referred to on p. 36, may be obtained very cheaply from any large builder's wood-yard, and can be fixed by the amateur without difficulty, in the same way as a hat and coat rail. In fixing the rail it must be remembered that the wall-paper will not reach beyond it, and some care must therefore be exercised in deciding upon its position. A good deal will depend upon the treatment of the space between the rail and the cornice or ceiling. Borders or friezes suitable for filling this space can be obtained in all widths

up to 7 in., but beyond, they are procurable only in widths of 10½ in., 18 in. and 21 in. If, therefore, it is desired to give a finish to the wall-papering by adding a frieze, these widths must be borne in mind in fixing the rail. For use with picture-rails special hooks as shown in Pl. XIX, Fig. 2, are made. These are obtainable at any ironmonger's shop.

Fitting Locks on Doors.—The lock most commonly used on ordinary room-doors is the *rim-lock*, and is the one which the amateur will be able to fit with least difficulty. In fitting such a lock the first thing to do is to decide upon and mark the exact place on the door to which the lock is to be fixed, and cut away sufficient wood from the edge of the door to let in the iron plate projecting from the bolt end of the lock. The lock should then be held in position, and the exact places where the key-hole and hole for the spindle are to be cut marked with the pointed end of a scriber. The hole for the key should be made by boring holes no larger than is absolutely necessary for the passage of the shoulder of the key at the top and bottom of the place marked, and cutting out the wood between these holes by means of a fine key-hole saw. In boring the hole for the spindle, great care should be taken that the hole is square with the surface of the door, as difficulty will otherwise be experienced in fitting the spindle through the hole in the iron lock when it is screwed on. A simple method of keeping the boring bit horizontal in this operation is to slip a small metal ring over the shank of the bit. Any departure from a horizontal position during the operation of boring will be shown by the ring sliding along the shank towards or away from the door when the bit is turned. To ascertain whether the hole is true from right to left a square should be used as a guide. The locks should be secured to the door with the round-headed screws sold for the purpose, though it will be necessary to use ordinary flat-headed screws in the flange on the edge of the door. The box-staple, which receives the bolt of the lock, should be fixed in position after the lock has been screwed on and the bolts turned. Care should be taken that the inside does not bind on the catches, but that there should be a certain amount of play to allow for sinking or warping of the door. In some cases, it will be necessary to screw on a piece of wood under the staple to serve as packing and bring the staple forward; in other cases, it must be let into the moulding. Finally the knobs and spindles should be fitted.

Locks are liable on account of the dampness of the air at certain

times and the entrance of particles of dust, etc., to get rusty and dirty inside, and it is desirable that the amateur should at times take his locks to pieces and give them a good cleaning and oiling with olive oil, which will make them work smoothly and pleasantly. Space forbids a lengthened description of the various patent arrangements for the knobs and spindle, but one of the best patterns of the ordinary brass door knob is shown in Pl. XIX, Fig. 3. In this pattern the holes for the screws which secure the knob are drilled right through the spindle. The white china door-knobs, also illustrated, are often used where appearance is a consideration.

The worst of the old-fashioned spindle and knobs at either end, attached by means of a small screw that enters a semi-spherical depression in the spindle, is that the screw becomes loosened by constant use and ultimately drops out, when the handle, of course, comes away from the spindle. This, however, is entirely obviated in the new kind of door-handle, or "furniture," as it is technically called, by the peculiarity of its construction. The edges of the spindle are notched, forming a screw-thread, up or down which the knob may be screwed. When the handle has been screwed up the spindle to a sufficient extent, a dove-tailed key is fitted into an opening made for it in the base of the knob. The knob is thereby firmly attached to the spindle, and cannot be moved from its position or in any way detached from the spindle, until the key is removed.

The manner of fitting a *door mortise-lock* differs somewhat from that of fitting a rim-lock, inasmuch as the former has to be let into the solid wood of the middle rail of the door. The lock should be first held in position, and the places for the key-hole and spindle marked as in the case of the rim-lock. This should be done on both sides of the door. To ensure perfect accuracy, a good plan is to make a template of thin metal with the end bent over at right angles and an opening cut to fit over the bolt of the lock. The key-hole should then be cut, and the hole for the spindle bored as already described. If the amateur has a lathe, a very useful guide for the twist bit may be made in a few minutes, by securing a piece of wood about 2 in. thick and 3 in. in diameter to the face plate, and boring through it a hole large enough to just take the bit. If, when boring, the bit is put through the hole and the piece of wood held with its faced side against the door, the bit will enter in the right direction, and any tendency to depart from the square will be shown by the movement of the piece of wood, and at once checked. The mortise for the lock should,

as far as possible, be bored out and afterwards cleaned out with the chisels. When this has been done, the flange may be let into the edge of the door, great care being taken to go no deeper than is necessary, as otherwise the holes bored for the key and the spindle will be thrown out of place. The position of the striking plate should be determined in the same way as described in connexion with the fitting of a drawer-lock.

In recent years the Yale rim night latches have come into common use. These locks may be obtained both as rim and mortise locks. The method of fixing is similar to that described in the case of ordinary door-locks, but great precision is necessary in marking the place for the key-hole. Instructions for fixing are sent out with each lock, and these give the exact measurements, including the distance from the edge of the door to the centre of the escutcheon of the lock. The lock is operated by a key from the outside, and by a knob from the inside. By means of a stop, the bolt may be "dead-locked," either in a locked or unlocked position

Cupboard locks are fixed similarly to drawer locks, but in the case of the cupboard lock, the hole for the key can be bored from the inside. In order that the job may be done as neatly as possible, it is a good plan to fix the lock in position, and try the key before the back plate has been sunk in the wood. Any slight adjustment which may be found necessarycan then be made without cutting into the surface of the door round the back plate, as would be the case if the bed for this had already been cut out. When the exact position for the lock has been found the back plate may be let in flush with the wood.

The fitting of locks to drawers and boxes has already been described in connexion with the making of those articles.

Household fixtures such as bells, ventilators etc., involving work other than that which falls within the province of the woodworker, are dealt with later (see p. 432).

CHAPTER XI

DOMESTIC REPAIRS

The amateur who has made himself acquainted with the principles upon which the various articles of furniture already described are constructed will find little difficulty in executing the repairs which from time to time become necessary, generally through rough usage. Before the actual work of repairing is

commenced, the damaged piece of furniture should be carefully examined and a clear idea formed as to the manner in which it is to be dealt with. All materials, such as glue, screws and dowel-pins necessary for the job, as well as the tools required, should be got ready. When glue is to be used the separate parts should be fitted together and held temporarily in position with suitable clamps or hand screws before any attempt is made to join them permanently, and if screws are also to be inserted the necessary holes should be bored.

Mending Chairs.—It will be useful in the first place to consider one or two of the injuries to which ordinary wooden chairs are most subject. The most common form of damage is where no actual breakage has occurred, but where, through undue strain and general rough usage, the legs and rails have been loosened and the chair has become "rickety." A fruitful source of injury to a wooden chair used in the kitchen, is turning it into a temporary drying-horse before the fire. The heat of the fire dries the wood and causes it to shrink, and as a natural consequence those portions of the chair which are glued together get loose. In such cases, the best thing to be done is to take the chair apart and re-frame it. If the dowels or tenons have worked loose it will not be sufficient to merely glue the parts together again. To ensure tightness the old dowels must be removed and replaced by others somewhat larger, and the size of the mortises must be slightly diminished by the insertion of thin wedges before the tenons are re-fitted. No attempt should be made to put a nail through the seat into the top of the leg, or through the leg into the end of the rail that connects it with the opposite leg. Ordinary chairs are generally made of beech or elm, and nails will not readily enter these woods. Indeed, both beech and elm, when the wood is not very thick, are liable to split when a nail is driven into the end of a rail, etc., on account of the closeness and crookedness of the grain. On the contrary, nails may be safely driven into deal in most cases, for the wood is soft, and the straight grain yields readily in all directions to afford a passage for the nail. When it is said that a wooden chair is made of elm, it must be noted that it is the seat only that is of this wood, the back and legs being generally made of beech, or some hard wood resembling beech in its general character.

If the rail of a chair breaks, whatever may be the shape of the fracture, it is useless to try to mend it. The best thing to be done, in every case of this kind, is to make a new rail. The old

rail, it is true, may be fished and spliced, but this mode of repairing a fracture is impracticable when the line of breakage is close to the leg. When through a fall, or any blow, the leg of a chair gets broken in a slanting direction across the leg instead of up and down its length, the best way is to saw the leg through squarely just above the fracture and then glue up the break. The glue should be allowed to set thoroughly, and the square joint should then be dowelled with long hard-wood pins which pass through the break into the solid wood.

It often happens that the side-pieces in the framing of the seat of a chair will break across close to the tenon by which the piece is attached to the back rail. There is manifestly no way of uniting the broken pieces by nails, screws, or dowel-pins, as such a joint would not be sufficiently strong to stand any strain. All that can be done in such a case is to screw an angle iron, which may be obtained from the ironmonger, into the angle formed by the side rail and the leg. If let into the wood and painted to match, the iron will hardly be noticeable. On account of their great strength and superior finish, amateurs will find these angle irons useful for connecting and strengthening the parts of various structures in wood as well as for mending chairs and supporting shelves.

Attempts to repair any damage done to a chair by nailing the broken or disconnected parts together are rarely satisfactory in their results. Driving in nails will only, as a rule, make the damage worse than it was before. If the corner of the seat of a cane bottomed chair gets loosened from the leg into which it is notched, the course generally adopted by the amateur is to drive a nail or two through the leg into the rails of the frame of the seat. The proper thing to be done is to bore a hole through the leg into the frame with a small auger-shaped bit, and after gluing the corner of the frame, to make a dowel-pin a trifle larger than the hole so that it may fit tightly, and after dipping the end of it in glue, to drive it into the hole. Two pins may be used, one through the back and the other through the side of the leg, their respective directions being at right angles to each other. This will effectually prevent any further withdrawal of the frame from the notch in the leg.

Elm is usually very cross-grained, and it sometimes happens that by undue pressure on the leg, perhaps by the rails that hold the leg to those opposite to it in the front and behind, that a piece of the seat itself has been broken off. To attempt to nail it on is useless. It must be held in its place by a clamp, and the holes bored through the broken part and into the seat with an auger

bit. The broken piece must then be glued and fastened to the other part of the seat with dowel-pins dipped in glue, the whole being held in a clamp until the glue is perfectly dry and hard. The leg may then be inserted once again into the hole after the end has been glued, and the rails also glued and clamped till dry.

Chairs with socket-castors sometimes get the castor broken off and the end of the leg is broken away with it. In this case a new piece to fit the socket of the castor must be obtained from the wood-turners, and this should be dowelled and glued on to the old leg. A similar method should be adopted when the ball feet of small tables, stools etc., have been broken off. It is impossible to describe any and every kind of damage that may happen through breakage, but what has been already said will prove generally useful to amateurs in the matter of mending broken chairs.

Chair-caning.—The re-caning of a chair may appear to the amateur to be a difficult matter, but in reality is a very simple operation.

The split cane, which may be obtained at nearly all basket-makers, is made in two or three different widths, and is sold by weight. The widths generally used are Nos. 1 and 2, approximately $\frac{1}{8}$ in. and $\frac{1}{12}$ in. respectively. A quarter of a pound is quite sufficient for two bedroom chairs.

In order to make the cane pliable and fit for use it should be soaked in clean cold water for 24 hours before the caning is commenced. In the meantime the old cane should be cut away from the seat frame, and the holes cleared by punching out the wooden pegs which held the ends of the old canes. If the frame is to be re-polished, this must be done before the caning is begun. A few hard-wood pegs should then be prepared for temporarily holding the cane in place until the final pegging is done.

In commencing work, take two long pieces of the No. 2 cane, and having tied the ends together, pass them up through one of the holes in the front of the frame; bring them across the frame to the opposite holes in the back, pass them through, pull tight and insert one of the temporary pegs. Then bring the ends of the long strands up through the next hole and proceed in this manner to lace the chair from front to back, putting in temporary pegs to keep the cane from slipping. The same operation is then performed across the seat from side to side, each strand being interlaced with those previously inserted and crossing it at right angles.

The third lacing is done with the coarse or No. 1 cane, diagonally from corner to corner, and one strand only should be used for each hole. The fourth lacing is also diagonal, but in the opposite direction to the third lacing.

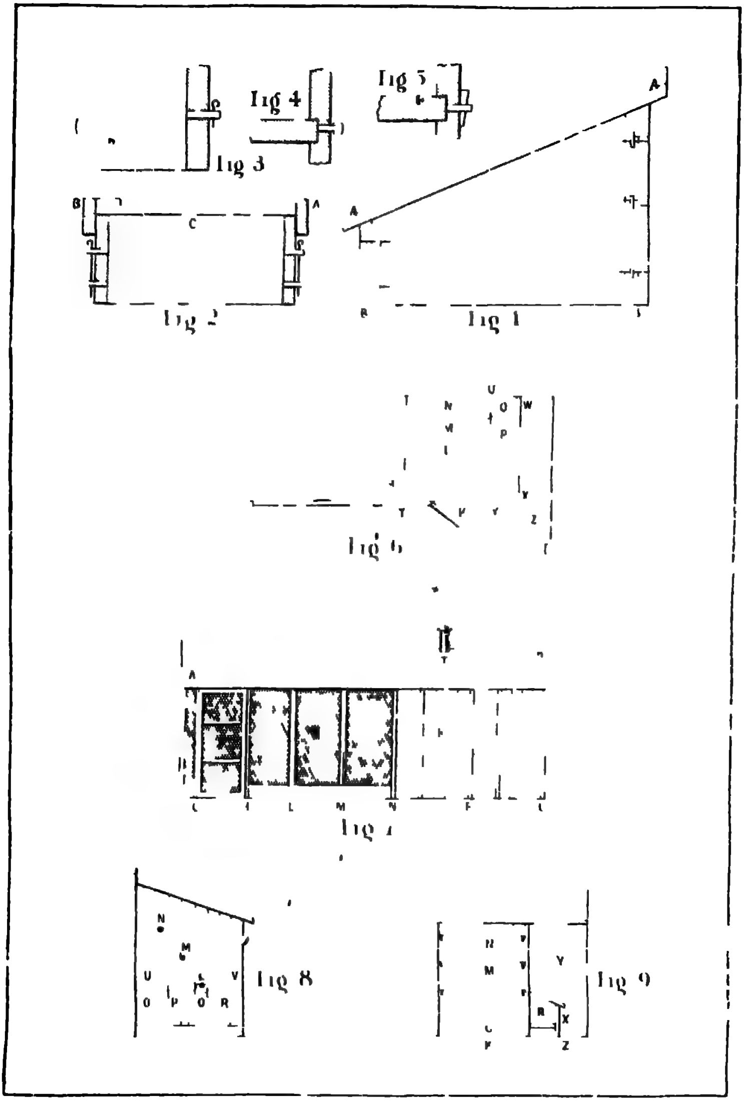
To finish off, permanent wooden pegs should be driven in at every other hole and broken off short, then to hide the unsightly appearance of the holes a piece of coarse cane is run round as a border. This should be held down at every alternate hole, i.e., the holes which have not been pegged, around the frame by passing over it a loop of fine cane. The loop should be formed on the under side of the frame, and passed up through the hole, the coarse border frame being threaded through it and the tying down cane then pulled tight.

The long ends of cane should not be cut off until all the work has been well pegged and tied down.

Upholstery (Pl. XX).—The amateur's efforts in upholstery will be confined almost entirely to the renovation and repairing of upholstered furniture. In the case of a chair in which the webbing has given way, the necessary repair may be effected either by putting on new webbing or by replacing the old webbing with wooden battens. In either case the bottom sacking and old broken webbing should be first removed, and the tacks carefully extracted. If battens are used they should be of tough hard wood about ½ in. thick and 2 in. wide. These should be nailed to the bottom of the chair so as to be under the centre of the coiled springs. The springs should be pushed into position and secured by means of fine wire twisted round them and passed through holes in the battens. A new piece of hessian should then be cut to the pattern of the piece removed, and tacked on to the bottom of the chair.

If new webbing is to be fixed, the end of the first strip should be turned over for ½ in. and fastened to the centre of the seat-rail with three or four ½ in. tacks. The other end of the strip should then be passed through an upholsterer's strainer and stretched perfectly tight across the frame in the manner shown in Fig. 1. Taking care that the web is straight, it should, whilst still tightly strained, be fastened down in the same way as on the other rail (Fig. 2). When this has been done the strainer may be released, and the web cut off at ½ in. from the edge. This end should be doubled over and nailed down. Other webs should then be fixed in a similar manner, the space between each web being not more than 2 in. Afterwards cross-webs should be fixed

Plate M. OUTDOOR and GARDEN STRUCTURES.



[illegible]

Plate N. RUSTIC WORK.

Fig 1

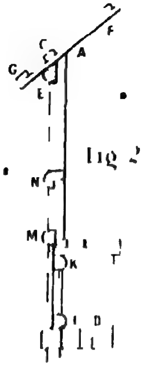


Fig 2

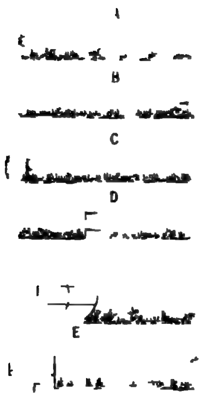


Fig 3

Fig 4

[illegible]

from the front to the back of the frame, and interlaced with the others.

The wire spiral springs are obtainable in all sizes from 4 in. to 12 in., the wire being of different gauges to suit the various purposes for which they are used. They are secured to the web by stitching the bottom coil down to the webbing with strong upholsterer's twine. For this purpose a curved spring needle is used. If it be decided to re-cover the seat, the first thing to do is to strip off the gimp and, with a small cold chisel knock out the tacks securing the edges of the cover. It should then be possible to lift off the cover. The dust which has collected should be brushed out. The next thing is to see that the springs are upright, and if necessary, they should be replaced by new ones which should be securely stitched to the webbing underneath, and the stuffing at the top. In measuring the stuffed portion for the new cover, allowance must be made, both in length and width, for tacking on To hold the cover in position for fixing on, it should be tacked in the centre of the seat with the pattern, if any, straight across It should then be secured at the back, commencing in the middle and working towards the ends. The tacks, ⅜ in. in length, should be placed about 1 in. apart. The corners should be doubled round to the front or back, pulled down firmly with the pincers and tacked through the double thickness The edges of the material may be trimmed with a sharp knife and covered with suitably coloured gimp. The gimp is nailed down with the small black pins sold by ironmongers for this special purpose. Leather bandings are generally secured with gilt or leather-headed studs.

CHAPTER XII

OUT-DOOR AND GARDEN STRUCTURES

As the general principles on which sheds and out buildings in the garden are constructed will be fully dealt with in a later section, it will only be necessary here to dwell on a few peculiarities in out-door structures in the garden, which cannot be conveniently treated elsewhere.

The Cucumber-frame.—First among these, the cucumber-frame, or frame and lights, presents itself This is a structure which is not only useful for raising, rearing and ripening cucum-

bers and melons, but also as a covering for a cold pit in which half-hardy plants may be protected from the severity of the winter. The description of this kind of frame and light will be sufficient to guide the amateur to the construction of similar frames for other garden purposes.

In Pl. M the details of the construction of the glass-frame are shown. Fig. 1 is an elevation of the side of the frame, in which is shown, among other things, the suitable slope of the light which lies within the side-slips, one of which is shown in Fig. 1 by A A, and in section by A B, in Fig. 2. A frame may be 6 ft. by 4 ft., or 6 ft. by 8 ft., the latter being double the size of the former. The side-pieces form a rebate with the sides of the frame, so that the light works up and down on the edges of the sides of the frame and clears the top and bottom nicely. The side-pieces confine the action of the frame, keeping the frame in its proper place, and preventing it from moving in a lateral direction and being pushed over the side of the frame. The top, bottom and sides of the frame may be dove-tailed together, but a large frame when put together in this way so that it cannot be taken to pieces, forms a heavy and cumbersome article to put away out of sight and under cover when it is not wanted. The amateur will find hints on glazing the light in Part III of this work. We may now describe the contruction of a frame that may be taken to pieces and put together at pleasure.

Stout boards that will be full 1 in. or even 1¼ in. when planed down, should be chosen. The sides must be made of the shape shown in Fig. 1 at A B B′ A′, the back part, A B, being about twice or three times the height of the bottom piece. This will provide a sufficient slope for the light. A convenient height for the front of the light is about 12 in. In order to take the frame to pieces and put it together again at pleasure, the front, back, and sides may be connected by cutting slots in the sides in a horizontal direction, and attaching eyes to the edges of the top and bottom in such positions that they will pass through the slots cut for their reception in the sides. When the eyes or staples, for either may be used, have been passed through the slots when the frame is put together, the whole structure may be kept together by passing wires through the loops of the eyes, as shown in Figs. 2, 3 and 4, or pegs through the loops of the staples, as shown in 1 and 5. In 2 and 3 the edge of the bottom is shown as simply touching the sides, but in 4 and 5, both of which represent the plan of a corner of the frame, the edge of the top or bottom is shown fitted into a groove ploughed for its reception

about 1 in. or 1½ in. from the edge of the side. The frame is more solid and air-tight when made in this way.

The end of the light is shown at C in Fig. 2. As full instructions for glazing the frame will be given elsewhere all that is necessary to impress on the amateur here is that if he is making his lights himself he can make his frames first and adapt his lights to it; but if he procures frames for his lights all ready made, it will be needful to adapt his frame to his lights, making an accurate working drawing to scale, in order to determine the dimensions of the frame with accuracy. No light for a frame of this description should be larger than 6 ft. by 4 ft. The frame may, if necessary, be 8 ft. by 6 ft. or even 12 ft. by 6 ft., but, to cover these, two or three lights must be used, being supported by bearers running from top to bottom of the frame, one bearer being required to take the edges of two lights where they meet in the centre of the frame, and *two* bearers for three lights. These bearers should be about 3 in. wide, halved into the frame at top and bottom, so that the upper surface may be level with the upper edge of the top and bottom. On this surface, between the frames of the lights, it is advisable to screw a bar of wood about 1 in. wide and the same thickness as the frames. Narrow grooves should be cut down the edges of the sides of the frame, and down the bearers upon which the edges of the lights rest. These serve to carry off any water that may make its way in between the edge of the light and the side of the rebate in which it moves.

For small lights for use in a side border, 4 ft. by 3 ft. will be found to be a convenient size. All frames should be well painted and receive a fresh coat yearly.

"Lean-to" Greenhouse.—A greenhouse built against the wall of a house so that the wall forms what may be termed the back of the greenhouse, the roof being formed of a single slope extending from the wall to the front of the greenhouse, is known as a "lean-to" greenhouse. The methods of constructing roofs on this principle as well as span and hipped-roofs, will be fully described in the concluding portion of this work. The roofs of glass structures should be made as slight as possible, having due regard to strength, and provision should be made for ventilation. The following description of a "lean-to" greenhouse, erected against a wall and having glazed ends in one of which is the door, will indicate to the amateur who desires to construct such a greenhouse, the manner in which he may proceed.

The greenhouse may be built either as a lean-to, against a brick wall, or independently of any wall or structure behind, in which case it must be furnished with a back. A useful feature is that this greenhouse can be easily taken to pieces and re-erected in any other place with little trouble. The ends are each framed in one piece to move bodily; the front and roof may be made each in one piece, or in separate parts. The most convenient way would be to make the woodwork below, shown as panels in the drawing, and the glazing above in four separate pieces, as the two pieces in the centre could then be made to open for ventilation. The roof may be made in three pieces, and in this case the two central panels should terminate at a cross-rail set across the frame midway to admit of small lights for ventilation above, between this rail and the top rail of the roof. The house stands on a platform or sill piece of oak framed separately, and the sills or lower rails of the framing above are screwed down upon it. It is almost needless to say that the oaken sill should be bedded on concrete, and that the floor of the house should be formed of the same material, sloped from all sides to one corner, at which an outlet and drainage should be provided for surplus water that may fall on the floor when the plants are watered. For the sake of ornament, circular heads may be made to the lights, if preferred to square or rectangular heads. The front and back, if the house be furnished with a wooden back, are bolted to the ends, and the roof to the uprights at front and back. The plate is mortised into the posts and a hole is bored with an auger through post and tenon until a recess notched in the plate below is reached, in which the nut is held until the end of the bolt has been passed through it. The nut, which is circular, with notches in its edge like the milling on a coin, is then screwed up tight with a screw-wrench made in the form of a large pair of bent pliers, until the post is brought as closely as possible against the tenoned end of the plate. The framing of the roof is secured in precisely the same manner, for even if the back be formed by a brick wall or the wall of a house or any other structure, a wall plate from end to end will be required to help in supporting the framing that forms the roof. A fillet is nailed on the sides of the roof to give a finish to this part of the structure, and, to prevent the rain from finding its way to the bolts, caps, generally of an ornamental character, are placed at the four corners of the roof.

Larger Greenhouse.—For amateurs who desire to build a

larger greenhouse suitable for the purposes of vinery, for the housing of chrysanthemums or dwarf fruit trees, the following description is given of a convenient form of house, a lean-to structure, 30 ft. long and 12 ft. 6 in. wide, which is made in a very simple manner. No illustration is given, as the amateur can easily work this out for himself from the following description.

Six posts of yellow deal, 5 in. by 3 in., or oak posts 4 in. by 3 in. and 9 ft. 6 in. in length, are firmly fixed and driven 2 ft. into the ground, the lower ends being previously charred and coated with coal tar. This is the back line of posts. Six other posts exactly similar, but only 4 ft. 6 in. long, are fixed 18 in. in the ground, forming the front posts of the house, the one rising 3 ft. and the other 7 ft. 6 in. above the ground level. Two posts at one end occupy the centre and form the door-posts. On the six posts, both at back and front, a wall plate is nailed to receive the rafters, one of which springs from each of the front posts resting on the corresponding back posts.

The rafters are 14 ft. long. A 9 in. deal, 3 in. thick, will make four of them. On the upper side of each rafter is nailed a slip of ½ in. deal 1¼ in wide, which will leave ½ in. on each side as rebate to receive the glass. The rafters so prepared are fixed in their place to the wall plates by having a piece cut out at each end to correspond with the angle of the back and front plates. They are then firmly nailed at back and front by strong spike nails, leaving a space between each rafter of 5 ft. which is called a bay; this is filled up by smaller rafters or sash bars, of a size proportioned to their length and the use they are to be put to—vines trained to them requiring stronger bars. A piece of ¾ in. deal board, 6 in. wide, nailed along the top of each rafter, so as to be even with their upper edges, forms the ridge board, leaving a groove to receive the upper end of the glass. A similar piece of 1 in. deal, 6 in. wide, let in by sawing out a corresponding piece out of each rafter at its lower end will receive the glass and carry off the water. The placing of the glass is a very simple process. Beginning at the top, a plate of glass 20 in. wide—each bay is divided into three parts by two intervening sash bars—is laid in the groove and fixed in its place by a brad driven into the rafter a bed of putty being first laid; and so on till the whole is covered in, open joints in the glass being rather advantageous than otherwise, if not too wide. No putty is used in the laps, as in this kind of glazing the pieces of glass are laid continuously end to end or edge to edge in the rebate, there being no lapping

of each pane over that which is immediately below it. Very little, if any, rain will make its way in between the joints. The ends of the houses are fitted up to correspond with the roof, only that above the doorway a large sash is fitted in for ventilation. These sashes at each end, and the front or side sashes will be found to be quite sufficient for the purposes of proper ventilation. Well-seasoned ¾ in. deal, planed and jointed, nailed outside the posts, forms the lower part of the house.

In the back wall, sliding shutters, 3 ft. by 1 ft., will afford ventilation to the roof, and about 3 ft. from the surface of the ground two similar sliding shutters will ventilate the lower part of the house behind and on a level with them. Ventilation is secured by sashes, 2 ft. 6 in. wide, and running the whole length of the house under the wall plate; below these sashes the space is filled in with boarding well-painted. In summer it is impossible to give too much air. The house is now complete except the door, which must open inwards for obvious reasons, and may be half glass or otherwise, as desired.

Within the house a trench 18 in. deep is formed, into which two steps from the outside will lead. This, supposing the trench to be 3 ft. wide, leaves a platform or border on each side of the trench 4 ft. 9 in. wide. The back border should be raised 18 in. and might be improved by a second terrace behind the first, of 14 in., supported by a 4 in. brick wall. The borders should have a loose and open surface, formed of old lime, rubbish and road sand mixed with manure. This surface should be laid 4 in. deep and then the whole should be forked over and mixed with the soil to the depth of 9 in. The structure, when complete, is admirably suited for the culture of vines, peaches and nectarines in pots, or for chrysanthemums. If a terraced border be made at the back, only two rows of pots could be placed, one in front of the other. In the front border two rows of pots should also be placed 3 ft. apart, the pots in the front row standing each in front of the space between two pots in the row behind.

As full information will be given in the third part of this work respecting the details of the methods to be followed in building sheds and out-houses for various purposes, we may confine our attention here to a brief description of one or more varieties of the different buildings which may be found, even in the smallest gardens, such as the aviary, the fowl-house, the pigeon-house and the summer-house, and the chapter will be concluded with some remarks on rustic work, including rustic seats and fences, suitable for the garden.

The Aviary.—An aviary is nothing more than a bird-cage on a very large scale. A level piece of ground having been selected, the area on which the aviary is to be built must be staked out with care. The amateur may make a four, six, or eight-sided building as he may prefer, but he will find a six or eight-sided structure will be far better in appearance than the four-sided aviary. Supposing it is decided to build an octagonal aviary, a stout post must be fixed in the centre and eight posts of yellow deal, about 2½ in. square, at the eight corners of the building. The bottoms of the uprights, which should be charred and well tarred, should be bedded in concrete, and the concrete bedding should be continued all round the site, to the height of the ground level or a little above it. To the bottoms of these posts and resting on the concrete sill should be nailed stout inch boards to serve as a baseboard or plinth. These may be from 9 in. to 18 in. wide, according to the size of the house. The boards may be recessed into the posts or nailed on the outside and neatly mitred at the corners. Around the top of the posts other boards should be attached in a similar manner. The rafters for the support of the roof should rest one end on the uprights and the other end against the post, in the centre of the building. This post may be dispensed with, if preferred, but in this case a block of wood must be introduced at the apex of the roof against which all the rafters may abut, after the manner of rafters against the ridge-board or pole of a span roof. The ends of the rafters should project beyond the baseboard, so as to take the drip from the roof beyond the outer surface of the baseboard. The roof may be weather-boarded or covered with boards placed edge to edge, vertically or horizontally, and covered in their turn with the ordinary roofing felt, or with asphalte roofing felt, which is an excellent material for roofing purposes. To the ends of the rafters, a little within the edge of the roof, an ornamental bargeboard should be nailed. The roof should be surmounted at its apex by a cap, on which a ball and spike is placed, which may be gilt. If considered desirable, drip from the roof may be prevented by running a light gutter of wood or zinc round the edge, and carrying the water to the ground through a pipe fastened against one of the pillars.

With regard to the manner in which the sides are filled up, this must depend very much upon the situation of the aviary. If it be in a very sheltered spot, all the apertures may be closed with frames, on which wire netting has been stretched. Of these, one must be made to open and shut, but to guard against

accidents it should be secured by a padlock. As it will be inadvisable to throw this door open at all times for the admission of water, etc., a swing-flap should be fitted at the bottom of one of the fixed panels, by means of which the bottom of the aviary can be reached easily. The birds will roost in the roof on perches running from the central pole to the rafters, and if there be no central pole, the timber against which the rafters abut should be carried low enough, say as far as the bottom of the ornamental bargeboard, so as to carry the inner ends of the perches. If the situation be exposed, three out of the eight sides, facing northerly and easterly, may be permanently boarded up, and painted or coloured white inside. It will also be desirable to have frames covered with painted canvas or straw matting, etc., which may be placed against any of the wired sides to keep out driving rain or a boisterous rough wind.

The bottom of the aviary should be of concrete, sprinkled with sand, and a little lime taken from an old wall or any old building. Brackets and supports can be placed within, on which the birds may build, but if possible these should be in such a position and so contrived that the birds may be out of sight, and in seclusion when sitting. It is scarcely necessary to say that the small-wired flap, as well as the principal means of entrance, should be secured by a padlock, and that one person only should keep the key and attend to the wants of the birds, as any carelessness in leaving the doors unlocked might lead either to the escape of the birds or the entrance of cats.

Amateur's Suburban Fowl-house (Pl. M).—The accompanying diagrams illustrate the construction of a suburban fowl-house. In Fig. 6 the plan of the fowl-house is shown. No dimensions are given, for reasons that have been already stated; but as suburban gardens and the yards that do duty as gardens are generally narrow, the fowl-house should be about 6 ft. or 7 ft. wide, and extend along the whole length of the wall at the bottom of the garden or along so much of either side as can be fairly given up to it. In the plan the house is supposed to be built across the bottom of the garden, extending from side to side. In Fig. 6, therefore, which is the plan, A B is the bottom wall of the garden, and A C, B D, parts of the side-walls contiguous to it. Three out of four sides of the house are provided for at once, and the expense of building is reduced to a minimum, the amateur builder being only called on to furnish the front, the roof, and the partitions and fittings within.

The plan of the yard is thus arranged : E is the run, entered from the garden or court without by the wire door F ; a partition S T divides the run from the roosting-place G, to which the fowls gain access by a hole cut at H, before which there is a latch or trap-door that can be closed at pleasure, as, for example, to shut the fowls up in the yard E, while the roosting-place G is being cleared out. The roosting-poles are shown at L, M, N, as they would appear when seen from above. These are placed at different heights, the lowest being at L and the highest at N. From the roosting-place, access to the nests O, P, Q, R, through holes cut in the partition U, V, which divides the roosts from a small enclosed place Y. The poles should be rough round poles with the bark on ; clothes props, cut to the required length, are the most suitable. The poles should be movable, and not fixed, as occasionally it will be necessary to take them down to wash them. The ends, which should be made square, should, therefore, merely drop into corresponding notches cut in brackets nailed to the partitions which enclose the roosting-place. When the trap at H is closed, the door at K can be opened and the roosting-place cleaned out without disturbing the birds. The nests O, P, Q, and R, as shown in plan in Fig. 6 are divided from each other by partitions ; the board in front, W X, should either take out or be let down on hinges attached to the bottom rail, so that the nests may be more easily cleaned out at intervals ; they are covered in by a slanting frame made in separate pieces so as to form a lid over each nest. The space Y may be used as a tool-house, or as a place for keeping odds and ends that are useful at times in the garden.

The method to be followed in arranging the fowl-house will be clear enough, and it only remains to explain its construction as far as may be necessary. The amateur is recommended first to make a strong frame for the front, as shown in Fig. 7, consisting of two rails A B, C D, one running the whole length of the house at the top, and the other at the bottom. If made of two pieces, the pieces must be scarfed together. The rails A B, C D, must be connected by strong uprights A D, B C, which must be fastened into the wall ; the most convenient way of proceeding will be to lay the bottom rail C D in position, and then to fix in it the uprights at the ends and the intermediate uprights at G, H, L, M, N, O, P and Q, which, it need scarcely be said, should be mortised into the rail. Corresponding mortises should be cut in the rail A B, which should then be dropped on to the uprights and wedged up. Supposing the height of the front to be 6 ft.,

and the wall at the back 8 ft., a wall plate should be nailed to the wall about a brick or two bricks below the top, and rafters laid from the wall plate to the rail A B, which will keep the front firm in its proper position.

Before putting on the roof it will be desirable to put up the partitions, shown at S T and U V, in plan in Fig. 6, to put up the roosting-poles, and construct the nests. Then the wired door F may be hung, and the wire netting stretched over the space between A D and the upright G, and from the upright H to the upright L, from L to M, and from N to O. The spaces between the uprights N O and P Q must be boarded up, after which the doors K, Z must be hung.

Lastly, the roof A B R S must be boarded over and covered. A gutter should be placed along the whole length of the roof from A to B to prevent drip, and the water should be carried off from the gutter by a pipe running down the wall on either side, and connected with a pipe leading to the drains of the house, unless it be desired to store the water for the use of the house and garden. If a gutter be made in the way described on page 427. the front may be finished with a crest-board which will add much to the appearance of the house. To insure ventilation a round zinc pipe about 3 in. or 4 in. in diameter, covered with a shallow conical cap raised above the pipe on suitable supports, and extending over and beyond the opening to keep out rain, should be let into the roof at the back in the middle of the roosting-place G. The air will be carried upwards and out through the ventilator by the air that enters at H. The doors at K and Z should be ledge doors and hung on T-hinges; the wire door F may be hung on butts. All the doors should be fastened by staples and padlocks, one staple being in the door, the other in the hanging-post, so that the hoop of the padlock may be passed through both and secured.

The Pigeon-house.—The form and construction of the pigeon-house will vary in accordance with the number of pigeons kept and the requirements of the amateur with regard to picturesqueness of appearance. The rule in building or making a pigeon-house is simply this, that for every pair of pigeons that is kept there must be a separate apartment. Thus, if one pair of pigeons is kept, a little box one foot every way with a slant roof above it to keep off the rain, and a ledge in front of the entrance on which the birds may settle, will be sufficient, but for more birds more room will be wanted.

For the accommodation for six pairs of pigeons, a box three

feet long, two feet wide, and one foot deep will be required. This will serve as the carcase of the building. The interior must be divided into six compartments of equal size, by one partition from end to end, lengthwise, and two in the contrary direction. For such a house as is now under consideration it will be better to put the shorter partitions across the box as floors for the compartments, and subdivide the divisions thus made by the vertical boards. The floors, as we may call them, should project beyond the sides of the compartments and the bottom board should project in the same manner. If the amateur is converting a case or box into a pigeon-house, he must nail on a ledge to the bottom, securing it by suitable supports, such as cleats nailed to the bottom, and projecting outwards to a sufficient distance. Two pieces of wood are nailed to the top to afford a bearing for the boards that form the roof, a cap being nailed over the joint at the top. The space enclosed by the roof can be utilised as another compartment. When the front is boarded over, holes from 3 in. to 4 in. wide, and about 6 in. high, should be cut for the admission of the pigeons. The holes should be made in the centre of the front. To prevent one couple from interfering with the other on the same level, it is better to bring out the central partitions to the outer edge of the ledges, and it will furnish additional protection to the interior if the sides of the house be brought out to the same line.

Pigeon houses are fixed to the sides of houses and stables or on the top of a pole to be out of the way of cats, but in such positions it is difficult to get at them when necessary. By a simple arrangement, however, the pigeon house at the top of a pole may be brought within reach without the necessity of climbing a ladder.

A sound strong, flour barrel should be procured and a pole which, when fitted, should be sunk at least 5 ft. in the ground. A hole, somewhat larger in diameter than the pole, must be made in the top and bottom of the barrel and into this a pipe of sheet iron or strong zinc must be inserted so as to allow the barrel to be worked freely up and down the pole. The interior of the barrel is divided by transverse partitions into three chambers and vertical partitions further divide each of these chambers into six compartments. It will be undertood that the head of the tub must be removed and the interior built up tier by tier after the insertion of the central pipe. The head must then be put on and the entrances to the compartments, previously marked out, cut out with a keyhole saw. Ledges should be fixed round the tub on a level with the floor of each chamber, supported on small

angle irons screwed to the sides of the tub. Brackets of wood may be used instead of angle irons, but the latter will be found more convenient. In the top of the tub two iron eyes are screwed, through which hooks are passed, attached to the ends of two ropes that pass over pulleys, screwed into the transverse timbers, which are mortised into the pole and with others help to sustain the conical roof which covers the tub when pulled up close to it, and protects the tub and its inmates from the rain. The roof should extend well over the tub and beyond it, because the centre of the tub is wider than the top and bottom, and it is necessary that the drip from the roof should fall clear of it. It will be seen that the tub can be lowered and raised conveniently at pleasure so that old nests may be removed, and the tub cleaned at any time. When raised to the top of the pole the ropes should be wound round cleats nailed on to the pole near the bottom to receive them.

The Summerhouse: Its Position.—The construction of the summer-house depends entirely upon the position in which it is placed and the purposes to which it is put. It is generally intended for nothing more than a cool and pleasant retreat in summer time, and so situated that it may command a good view of, and form a picturesque object when seen from, the house; if the garden be small, or if it be placed somewhere in extensive grounds, a spot is chosen with a pleasant aspect and outlook over the surrounding scenery. In such cases the summer-house is built open on all sides, or at all events on those sides which are turned towards the best point of the landscape; but if it be in a garden removed from a house, and is used as a place of security for garden tools, etc., it must be enclosed on all sides, and provided with a door and windows.

An illustration of a pretty summer-house is given in Pl. N, Fig. 1; it is one which may easily be made with the exception of the roof, which may be either thatched as shown, or made of wood, covered with felt and guarded at the angles, where the ends of the roofing boards meet and rest on the rafters, with rounded caps, surmounted at the point in which they all meet by a conical cap and ornament. Houses such as these should be hexagonal or octagonal in form. In either case, the method to be followed in its construction is the same, the chief point of difference being in the number of the posts that support the roof. First of all, let the amateur builder mark out a regular hexagon or octagon of the size required, and at each angle sink a stout fir pole; if the

bark be left on the poles it will add to the picturesque appearance of the building. When the posts have been well rammed in, let in blocks of wood, bevelled at top on the outer edge, and about 6 in. in width, between the posts and nail the ends securely to the posts with spike nails. Between the posts that form the entrance a broader piece may be fixed so as to form a step that projects beyond the face of that side of the building. The floor may next be formed by paving the area left within these pieces with blocks of fir cut from poles, the interstices between the larger blocks being filled with smaller pieces, the whole beaten level and the smaller spaces filled with sand and cement wetted and mixed together until it is of the consistency of thick cream and worked down between the joints with a broom. Next cut the poles level at the top and, to keep all firm, bind them together with a wall plate to receive the rafters running from the wall plate to the apex of the building.

The construction will be best understood on reference to Fig. 2, in which A B is a post of the building; C, a block, or section of a rail, let in between post and post; E, the wall plate at top; F, a rafter; and G, G, transverse pieces nailed from rafter to rafter to support the thatched roof. The rafters are all butted against and nailed to a hexagonal or octagonal block as the case may be. Halved into the pillars, and resting on the block C, is a rail H, nailed firmly to both. Another rail, K, is halved in the same way, about 14 in. or 15 in. above the level of the floor D. This rail serves to sustain the cross-rails as at L, which rest in front on an upright, and sustain other rails parallel to the sides of the building, which form the seats; the building below is closed in with fir poles, sawn in half, and nailed to the cleats or rails, H, K. A similar half-piece is halved into the posts as shown at M, and another as at N, and to these are nailed the pieces which form the rough and open lattice-work at the sides above the seat. The rail at N is formed of a *whole* length of fir pole, not sawn in two, but cut out in such a manner as to form a cap to the lattice-work as well as a cleat to which the upper ends of the cross bars are nailed. The cross bars will present a better appearance if they are halved into each other. In some positions it may be desirable to close in three or more of the sides of the building. This may be done by carrying the fir poles, sawn in half longitudinally, to the wall-plate, which in this case should be put inside instead of outside, as shown in the figure at E. The sawn poles may also be substituted for the lattice-work, and carried up to the rail N, the position of

which should be reversed, or a square cleat notched into the posts, and a half-piece of sawn pole nailed as a cap over this rail and the ends of the vertical half-poles. The seat is formed of these half-poles resting on a rail as at K in Fig. 2, and rails running on the tops of the legs that sustain the front of the sea placed round the interior of the building.

Rustic Work.—The style of the summer-house just described is closely akin to what is usually termed "rustic work," inasmuch as timber in its natural state is introduced into its construction. Properly speaking, rustic work includes all kinds of articles in the construction of which timber is used in its natural form, and always in the shape and sometimes in the condition in which it grew—that is, with the bark on, and only the smaller branches and twigs removed. Rustic work is chiefly applicable to the making of seats for the garden, which are always exposed to the weather, for arches and for rough fences and gates where irregular work is more in harmony with surrounding objects and scenery. For such kind of work as this the loppings of oak trees are most suitable, as their crooked shape renders them well fitted for working up into garden seats, fences, etc.

For framing together pieces of wood in their natual state, halving joints and the mortise and tenon must be chiefly resorted to. It must be remembered, however, that the wood to be joined is not square but more or less *round*, and that some modification of the processes described in connexion with the making of the joints mentioned must be made in order to ensure accurate fitting together and general neatness in the appearance of the work when it has been turned out of hand. What is meant by a modification of the processes of halving timbers together and making the mortise and tenon joint will be seen from an inspection of Pl. N, Fig. 3. In ordinary work, when two pieces of wood, each of which is rectangular in section—like the arms of a cross, for example—are halved together, a notch is cut in each piece to the extent of half the thickness, and the pieces thus prepared are fitted over and into the other; but when two pieces of round wood are to be joined in this way, a little consideration will show that it is not possible to proceed in the usual way, and that a semicircular notch, as at A, must be made in one piece,—generally that which assumes a horizontal position in the work—and the other piece dropped or fitted into the rounded notch thus made. When it is absolutely necessary to cut a notch in both pieces, it is better to make the width of the notches less than the dia-

meters of the pieces to be fitted together; and having done this *pare away the sides* of each piece that drops into the notch in the other, so as to allow of one piece entering the other without difficulty, and prevent the parts that are left unfilled on each side from showing too conspicuously. The mode of doing this is shown at D; the object being to make a neater halved joint. When one piece of rounded wood has to be nailed to another or against another, the joint being pretty well out of sight, or when a piece of wood has to rest on a transverse rail whose surface is flat and not rounded, the end may be cut as shown at B; and, when pieces have to be cut to fit into the corners of other pieces joined at right angles to each other, the ends should be cut away to fit with accuracy against the rounded parts of the pieces as at C. In making a mortise and tenon joint the shoulder of the tenon should be rounded or hollowed out as shown at E; and unless it is necessary for the sake of making the structure as strong as possible to have a tenon as wide, or nearly so, as the diameter of the wood, the tenon may be made in the form of a pin, as shown at F; the mortise for its reception being bored with a stock and bit or auger instead of being taken out with a chisel. Great nicety is required in making a close and accurate joint, but a little practice will enable the amateur to do this without difficulty.

In making garden furniture of this description, the amateur carpenter must work for the most part without a drawing, as the work to be done is irregular, and it is necessary to select such pieces as may be suitable for his purpose, first for the frame and then for filling in, taking care that pieces which occupy similar positions match as closely as possible without being symmetrical or perfectly alike.

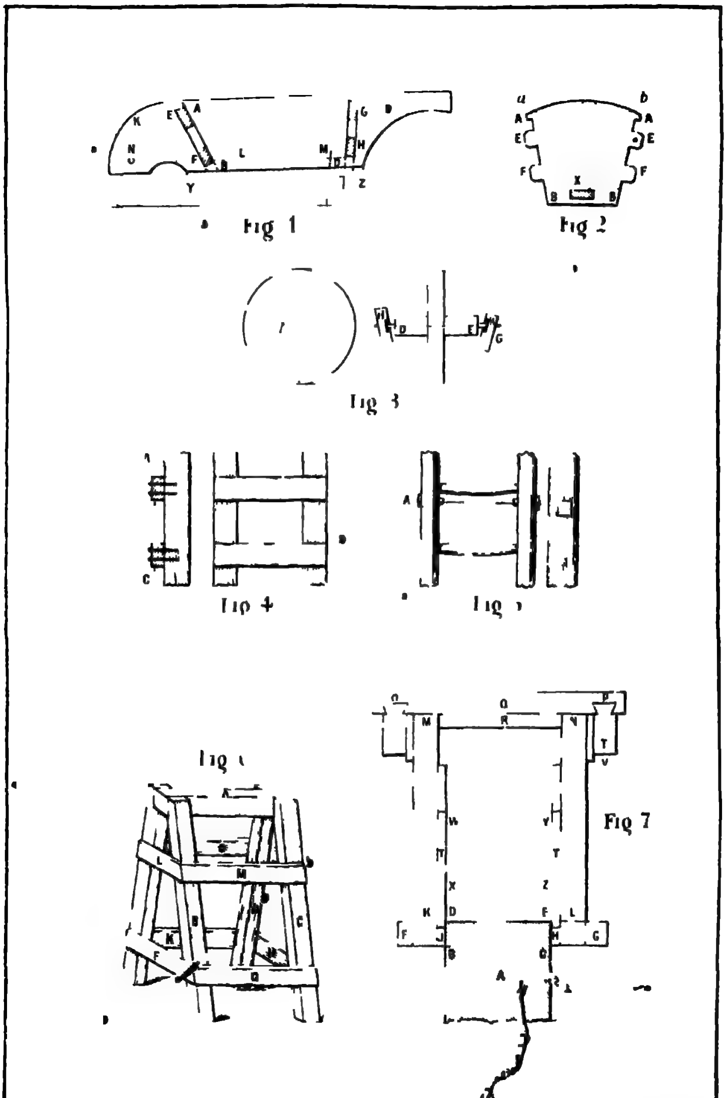
Garden Seat.—In the examples chosen for garden seats the work is as straight as possible, and may be executed with poles of fir or larch, ash, alder or hazel. For the bench shown in Pl. N, Fig. 4, stout pieces must be selected for the uprights at the four corners, into which should be framed the rails that form the front, back, and ends of the seat. The leg or support in the centre of the front should be mortised into the rail that rests on it, and at the back the rail should be halved into the two supports or uprights between those at the ends, and these uprights should extend to and rest on the ground. The topmost rail in the back is halved into the uprights; the central rail consists of a piece mortised into the uprights. The ornamental work is formed by bending pieces into the angles of the framework already formed, and strengthening them and

retaining them in their places by cross-pieces issuing from the angles made by the smaller vertical pieces of the back, with the rails at top and bottom. The ornaments in the angles of cross-pieces and elsewhere may consist of large fir cones, or of round pieces of wood, cut transversely from poles, and fixed in their places, as the fir cones must also be fixed, on stout wires. The arms at each end are formed of pieces of poles put on in a slanting direction and supported in the middle by uprights from the end rails of the seat. At the sides, the uprights are connected near the bottom by horizontal rails, for which diagonal braces are substituted in the front. The seat is of split poles, nailed at the ends to the front and back rails of the seat, and in the middle to a flat central rail running from one side of the seat to the other.

Garden Chair.—In Fig 5, representing a garden chair, a round piece of wood is selected for the seat, and into this three legs are inserted, which are connected by diagonal braces. The back is formed of three pieces securely spiked to the seat, into which they may be notched, and connected at the top by transverse rails Support is given to the back by braces attached to the side pieces of the back at one end and to the sides of the chain at the other The seat is finished by covering the foundation with split hazel sticks and nailing a hoop of split hazel round the edge. Amateurs will find wooden hoops that have been used for casks very useful for work of this kind, as by using them they are saved the trouble of splitting the sticks, which is by no means easy work

Rustic Steps.—As a means of ascent and descent from one level to another, rustic steps and fence will be found very picturesque. The trunks of four small trees may be let into the ground to form posts at the top and bottom of the steps and support pots or ornamental vases containing plants. These posts are connected by boards placed at the requisite slope to form the sides of the steps, the steps themselves being formed by earth well rammed and held in place in front by boards attached to cleats nailed to the sloping sides. Balusters of gnarled oak are placed between the posts and above the solid part of the sides, and a rustic finish is given to the whole by nailing pieces of fir poles, cut to the requisite length and split in half, to the front of the steps, The sides of the steps are also finished in the same way. It is unnecessary here to enter into minute details of construction, for the amateur who has followed us step by step through these pages, combining actual practice with the theory of the carpenter's art, will find no difficulty whatever in determining these for himself

Plate O. BUILDER S PLANT.



[illegible] Construction of wheelbarrow [illegible] Construction of ladders
(6) Trestles [illegible] Mould for [illegible]

Plate P. BRICKWORK.

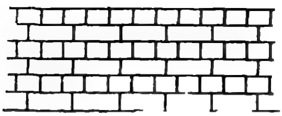


Fig 1

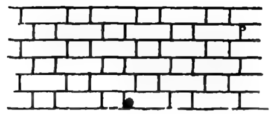


Fig 2

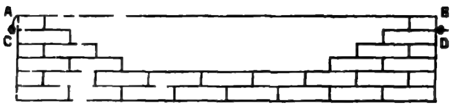


Fig 3

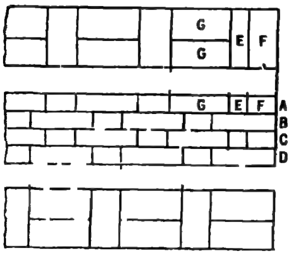


Fig 4

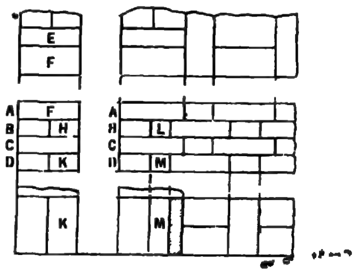


Fig 5

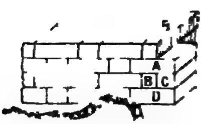


Fig 6

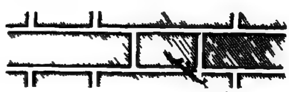


Fig 7

(1) English bond (2) Flemish bond (3) Method of building wall (4) Use of closers (5) Forming quoin or corner (6) Reveal in brick work (7) Tuck pointing

PART III

Household Building Art and Practice

CHAPTER I

BUILDING FOR AMATEURS—THE PLANT REQUIRED.

An exhaustive treatise on building processes would extend far beyond the scope of this work, the purpose of which is in the present section to bring to the notice of the amateur the simple operations in each branch of the building trade which he himself may be able to perform, and to furnish him with such knowledge as will enable him to form an opinion as to the quality of the work done by the skilled workmen whom he must at times call to his aid.

It will be understood, therefore, that in the following pages it will be sought to show what an amateur can do in each and every branch of the building trade; and how he must set to work to do it, rather than to furnish anything approaching a full and complete course of instruction in these, which would be comparatively useless. Although work incidental to each trade may be touched on, in no case will a detailed account be given of any process which the amateur would find too difficult or impossible to carry out.

It is in doing repairs of an ordinary nature that the amateur will find practical knowledge of the arts connected with the building trades of use to him, in the first place. Secondly, he will find it of equal value in constructing any small building for use or ornament, or for both, out of doors, or for making any appliance within doors; and thirdly, as it has been already urged, he will find it of even more value in enabling him to look after men who may be at work on his premises, and in seeing that the work is done in a proper manner.

Carpentry and gardening are the arts to which most amateurs

naturally turn their attention. The latter does not come in any way within our scope, but it is fair to suppose that most buildings that the amateur artisan will ever carry out will be chiefly in connexion with the garden. The processes involved in carpentry, and the manner they may be turned to practical account, have been dealt with in the other sections of this work, and there will be no occasion to revert to them. In this part it is our business to consider constructive work or repairs that the amateur may carry out in connexion with the house indoors, and the garden and all parts pertaining to it out-of-doors.

The building trade differs in some measure from other trades inasmuch as whilst in most cases the various branches have been created by actual division and subdivision, the building trade is rather an aggregation of various trades and their separate departments. which have become affiliated, as it were, and grouped together.

Various Branches of Building Trade.—Taking each a prominent and active part in the building trade we find the excavator, bricklayer, mason, pavior, slater, plasterer, carpenter and joiner, sawyer, ironmonger, smith and founder, zinc-worker, wire-worker, bell-hanger, gas-fitter, plumber, painter, decorator, sign-writer, gilder, paper-hanger, and glazier—a goodly array of tradesmen and artisans whose aid and co-operation are absolutely necessary in building and finishing a house.

Let us endeavour to classify and group these trades, and look into the part that each takes in building work, and, having done this, let us see to what extent in the work of each the amateur may go, and of what it will be most useful for him to have some slight knowledge; for it must ever be remembered that such knowledge is useful and even essential to a man who occasionally has workmen on his premises, even if he never put his hand to anything of the kind as an amateur, for it will enable him to give a general superintendence to what is going on, and to check in some measure the charges that are made for work done.

The Excavator.—The excavator, as his name implies, is engaged primarily in digging—in preparing, by means of pick and spade and barrow, for the foundations of a house, in levelling the spot on which it is to be built, in taking out the trenches for its foundations, and in preparing the approaches that lead to it. He is further employed in mixing concrete for filling up foundations and for making concrete floors, and in making paths, roads, etc.

The Bricklayer and Mason.—The bricklayer, mason, pavior, slater, and plasterer work in brick and stone and mortar, and with various materials. The bricklayer puts up walls and arches and chimneys in brick, a prepared material made ready to his hand in a certain size; the mason, on the other hand, builds with stone of all kinds, and is engaged in cutting and preparing such stone-work as may be requisite in a brick house or house of stone, and in fitting its various parts into the places they are destined to occupy. The pavior lays stone flooring composed of flat paving stones or materials similar in form, and flooring of bricks and tiles.

The Slater and Plasterer.—The slater covers in houses with slates, which are thin plates into which slate or certain kinds of laminated stones can be split with ease, and he is also engaged in forming roofs of tiles of various kinds, made and specially adapted for this purpose. Lastly, the plasterer imparts a smooth coating to the interior walls of houses and their partitions, and covers the exterior, if necessary, with a coating of stucco, cement, plaster, or rough casts—rough or smooth, as the case may be, formed chiefly of lime or cement.

The Carpenter and Joiner.—The carpenter frames together the timbers that enter into the construction of a house, and lays the flooring, etc., and the joiner puts up the staircases and all panelling and skirting required, makes and hangs the doors, makes and fixes the window-frames and sashes and puts up all the interior fittings of a house that are made of wood.

Metal-Workers.—Another group of mechanics work in metal. The ironmonger supplies all the articles, such as hinges, locks, stoves, ranges, sash-fasteners, etc., that are required in a house, with knockers, bells, letter-boxes, door knobs, and other such necessary furniture; but the ironmonger is a middle man and not an artisan, acting as a medium between those who manufacture these specialities and those who buy and use them. The smith and the founder take an active part in building work, forging bars that may be necessary to insert under the arches of chimney-breasts and other iron-work; he also makes and sees to the fixing of columns, girders, tanks, iron doors, furnace work, boilers, hot-water pipes and their connections, gratings over areas and holes, iron bars for windows, and a variety of articles that will not admit of enumeration. The zinc-worker makes chutes in zinc for the conveyance of water, and covers

roofs, generally small in size, with sheets of zinc. The wire-worker bends, cuts, and forms wire into wire gratings, and prepares trellis wire-work, window blinds, etc. The gas-fitter sees to the connexion of all pipes conveying gas, and the fixing of gasaliers, etc.; and the plumber looks to all work into which enters the fitting of leaden pipes for the conveyance of water, and therefore to the fixing of cisterns, water-closets, ball-taps, sinks, etc. The bell-hanger fixes bells, and looks to the mechanical arrangements by which, by means of cranks, springs, and wires, bells are connected with the handles, by means of which they are set in motion.

The Painter and Decorator; the Paper-hanger.—Lastly, we come to the painter, who covers wood-work and metal-work with a coating of colouring matter, mixed with oil and turpentine, called paint, in order to preserve the one from decay and the other from corrosion through the action of the weather, and colours walls, ceilings, etc., with oil colours, or more commonly with distemper. Artistic work on walls and ceilings is usually carried out by the decorator, who works out a design with the brush, or quickly prints a pattern by aid of stencil-plates. The aid of the sign-writer is sought to paint the name of the house or its number on the pillars of the entrance gate or on the front door; and that of the gilder in covering all surfaces that are to be gilt with leaf-gold. The paper-hanger covers the interior surface of walls with paper-hangings, often beautifully and artistically printed in colours; and the glazier fixes panes or sheets of glass into sash-frames, and in skylights, green-houses, conservatories, etc., after cutting them to the size required

Thus, in digging and preparing for building work, putting up walls, etc., and covering in with the roof; fitting, framing, and finishing in wood; working in metal of various kinds; painting and glazing, and the general work of decoration we have placed before us broadly, for convenience of consideration, the principal divisions of building work. classified partly according to the materials employed in each and partly according to the nature of the work.

Although it is not to be supposed that the amateur who has but little time at his disposal for such kinds of work can attain in any of these branches of the building trade the skill of the professional workman, there are, on the other hand, many simple processes, in each branch of which he may acquire sufficient knowledge to enable him to do much of the work in a creditable

manner. The satisfaction which he will feel in the result of his efforts will be more to him than the mere money which he will save. Further, the ability to do his own household repairs will often mean to the amateur a considerable saving of time, inasmuch as he may be able to do a thing directly, instead of waiting for it to be done at the convenience of the workman, and in addition to this much inconvenience and extension of damage, which might result from letting things remain as they were till a workman could be got to attend to them. The old proverb says aptly enough, " A stitch in time will save nine," and no one will appreciate its truth better than the amateur who is capable of helping himself.

Excavating.—The work of excavating can easily be done by the amateur, and he will find no difficulty whatever in making and using concrete. In connexion with this kind of work lies the making of garden walls and paths of all kinds, and it will be an undoubted advantage to the amateur to know how to do these things. The building of walls with brick and stone is by no means as easily done as other kinds of work that fall more naturally within his compass; but, at the same time, it is desirable to know how to repair and " point ", as it is technically termed, a piece of garden wall; to fix a step that has become loose with cement; to put a piece of paving to rights; and to repair a piece of plastering that has been displaced by damp or other causes.

Smith's Work.—Similarly the amateur may not be able to accomplish much in smith's work, but it is certainly of advantage to be able to work in iron so far as to be able, by aid of fire, hammer, and anvil, to beat a piece of iron into any required shape, to drill a hole, and to turn a screw. Casting, which necessitates the melting of metal in a furnace and running it into a mould, is an operation which may well be left to the iron-founder; but it is useful to possess an iron ladle, and run in lead round an iron bar or rail that has been loosened in the socket cut for it in a stone coping or step.

Zinc and Wire-working.—Zinc-working, as far as making a simple chute and covering a small flat roof are concerned, and wire-working in the construction of a wire trellis, hanging basket, sieve for sifting earth or cinders or repairing such articles, is far more practicable.

Plumbing and Gas-fitting.—Soldering and simple working in

sheet metal are matters with which the amateur may readily make himself acquainted. Plumbing and gas-fitting, which if badly and inefficiently done may involve serious consequences should be left to professional artisans; but it is as well to know how to stop a leak in a pipe on an emergency, how to take down a gasalier, clean it, and put it in its place again, and how to substitute new gas-burners for old ones with safety.

Bell-hanging.—Bell-hanging is a somewhat difficult and tiresome undertaking, but the amateur will find it convenient to be able to effect necessary repairs or even at times to fix a new bell, and arrange the cranks, wires, and pulls by which it is moved.

House-painting and Decorating.—In the decorative portions of the building trade he will find no very great difficulty. House-painting—that is to say, covering wood or metal with a uniform surface of oil paint—may be easily managed, and to a person possessed of taste and manual skill the work done by the decorator will present no very great difficulty.

Paper-hanging and Glazing.—Paper-hanging requires nothing more than care and a certain amount of manual dexterity. Glazing is more easily done than most of the work that had been mentioned, although perhaps for this reason it is less interesting. Still, it is work that should be taken up and carried out by the amateur, as he can put in a pane of glass for about half the price at which a professional glazier will do it if the work be such as can be done at the shop, in the case of the glazing of a light for a pit-frame, etc., and for from one-sixth to one-fourth the price charged if it be a window.

Amateur's "Plant."—Every amateur who makes up his mind to go in systematically for work of this kind should take care to be possessed of the "plant" necessary for carrying it out. The tools that are absolutely necessary for the performance of each kind of work will be specially described in the chapter and section devoted to its consideration; but there are a few things that may be mentioned here as being generally necessary for all kinds of work more or less, and with which the amateur should provide himself.

House or Shed for Plant.—A separate shelter of some kind should be provided for any building apparatus that the amateur may possess, or intend to possess. It must not be stowed away in his carpenter's shop, if he have one, for it will be in the way, and

by hindering him in his carpentry and joinery will prove a nuisance. "A place for everything, and everything in its place" should be carried practically into effect by the amateur with regard to all his tools and appliances, for every kind of work that he may undertake.

Useful Building Plant for the Amateur.—With regard to "building plant," strictly so called, it is desirable for the amateur to possess a ladder or two, one shorter and the other longer, a barrow, a set of steps, a couple of trestles, three or four scaffold-boards, some cords, and perhaps half a dozen scaffold-poles, and putlogs or cross-timbers, one end of which is inserted in the wall as it is being raised by the builders, and the other end lashed fast to a scaffold-pole by a piece of rope. A half cask, two or three buckets of galvanised iron, and a broad piece of boarding, consisting of three or four short boards nailed on to ledges, and an iron pulley or two will also be found useful.

Scaffold-boards: their Uses.—The scaffold-boards may be purchased at the timber-yard. They should be 11 in. wide and not less than 1¼ in. in thickness, and should have hoop-iron nailed round each end to keep them from splitting. Besides forming a platform when supported on trestles or putlogs these boards are handy in forming a sort of path on soft earth for wheeling soil, gravel, manure, etc., from one part of the garden to another.

Putlogs and Scaffold-poles.—Pieces of stout quartering will serve as putlogs, and may be bought ready sawn. Scaffold-poles—under 20 ft. in length will be tall enough for the amateur—can also be bought at the timber-yard, and ropes sufficiently good and strong enough for his purpose may often be procured from the marine storedealer. The broad piece of boarding, useful for mixing mortar or cement on, can be made by the amateur out of some spare boards.

Ladders and Wheel-barrow.—If the amateur is not already provided with a ladder, a wheelbarrow, a set of steps and some trestles, he may make these for himself very easily. The method of making the steps has been described in a previous chapter (see p. 227). The barrow will prove a somewhat more difficult job, but there is no serious obstacle in the way of making it, as we will show presently. Of late years a convenient iron barrow has been introduced, consisting of a receptacle of sheet iron, resembling a broad, shallow box, supported on an iron frame-

work furnished with handles and a wheel. This barrow has the merit of being strong, light, and easy to wheel along, even on comparatively heavy ground.

Barrow: how to make. (Pl. O.)—Let us proceed first of all, to describe the barrow, which should be made of elm, as this kind of wood will resist the destructive effects of moisture better than any other, and, indeed, will last for many years under all kinds of conditions. If the amateur is not inclined to work wood so tough and hard as elm, he must content himself with good sound deal. The parts which compose the barrow may be enumerated as the two sides, the front, the tail board, the bottom, the wheel, and the legs. The shape of the sides is shown in Fig. 1. No dimensions are given, as the size of the barrow must be suited to the power of the person who will mostly use it; and the best thing the amateur can do is to take the dimensions of a barrow that suits him, and from the figures given make a working drawing to scale. The sides are precisely alike, and the solid line in Fig. 1 shows the exact shape, the line at the bottom being parallel to that at the top. A shallow groove must be made in the *inside* surface of each side, as at A B, C D, and in these grooves mortise holes must be cut, as at E and F in A B, and G and H in C D. It will be noticed that the slant given to the groove A B is greater than that given to C D. The reason is that by doing so the front board is kept out of the way of the wheel, the position of which is indicated by the dotted circle K, and that any material with which the barrow is loaded can be turned out all the more easily when the barrow is canted over. Fig. 2 represents the front board: the projecting parts at A and A rest on the top of each side, and the mortises on each side, lettered E and F, fit into the tenons so lettered in Fig. 1. The tail board is made in the same manner, but it need not be higher than the dotted line *a b* in Fig. 2. A mortise, X, should be cut in both front board and tail board, the upper part of the mortise hole being just on a level with the bottom line of the sides. These holes serve to sustain a stout slip of wood, which in its turn helps to give strength to the bottom and hold it up. Its position is shown by the dotted line Y Z in Fig. 1. When the front board and tail board have been put in their places, and the parts brought tightly together by a few blows of a mallet, lines should be drawn with a pencil, or scribed with a bradawl or any sharp-pointed instrument, to show just where the outside surface of each side comes. The parts must then be knocked apart and

holes bored through the tenons with a large gimlet, rather outside than inside these scribe-marks. The sides and front board and tail board must be once more put together, and stout iron pins, or, if the tenons and the holes in them be large enough to admit of it, strong wooden pins of oak or ash driven through the holes bored in the tenons. The bar which is to assist in sustaining the bottom is then to be driven through the mortise holes made in the front board and tail board, and the bottom, made of *one piece of elm* if possible, cut so as to fit accurately and tightly into the space at the bottom of the framing formed by the front, back and sides, and rest on the bar below, to which it may be secured by nails, or three or four 2 in. screws. The sides, front and tail boards should then be nailed to the bottom with 2 in. clasp nails.

The wheel should be put in place before the pins are driven through the tenons of the front and back pieces, so that the projecting irons at each end of the axle may be thrust through the hole N made in each side to receive them. If the amateur can buy a second-hand wheel of the marine-store dealer, which he can generally do, it will save a good deal of trouble. He can then make the frame of his barrow to suit the wheel. If, however, he has to make one he must proceed in the following manner :—

Cut out a circular piece of board 12 in. in diameter, and exactly in the centre cut a square mortise, as shown at A in Fig. 3. The wood for the wheel should not be less than 1 in. in thickness, and elm is as good as any that can be got for the purpose. If the amateur cannot get a piece of elm, he must make his wheel 11 in. in diameter and use ⅝ in. stuff, cutting out two circles and screwing them tightly together so that the grain of one piece may run in an opposite direction to the grain of the other. A piece of hoop iron should be bound round the circumference in either case, fastened with nails, in the centre if the wheel be solid, but alternately, first near to one edge and then to the other, if it be composed of two pieces. A square piece of deal—or better, oak or ash—should be cut to key into the square hole as shown in Fig. 3. This forms the axle. Precisely in the centre of each end of the axle should be driven an iron spill or piece of iron, called a gudgeon, square at the end that is driven into the wood and round at the other. These should project just far enough beyond the ends of the axle to go through the sides and extend from ½ in. to ⅝ in. beyond their outer surface. These gudgeons are shown at D and E, and the manner in which they should project beyond the sides at F and G. A small iron plate about ¼ in. thick should be let into the side of the barrow on the inside surface to receive the

gudgeons, as shown at H and K. These prevent the wearing away of the wood which would otherwise be caused by the friction of the gudgeons. It will be noticed that as the sides of the barrow approach closer together at the bottom than at the top and are slanting, the holes through which the gudgeons pass must be bored in a correspondingly slanting direction.. This is apparent from the section of the sides shown at F and G in Fig. 3. If thought desirable, the axle can be tapered from the centre to the ends, and rounded on either side, and ferules fitted over each end before the gudgeons are inserted. The ferrules should be made red hot before they are driven on the ends of the axle. As soon as they are on, they should be plunged into cold water, which makes the iron contract and fit tightly on the wood.

To finish the wheelbarrow the legs must be added. These must be cut so that they may be fitted closely to the slanting sides, and yet be upright as far as the outer surface is concerned. They should be screwed on to the sides with 2 in. or 2½ in. screws, according to the thickness of the legs, just in front of the tenons of the tail-piece, against which they may be abutted, or set perfectly upright, if the maker of the barrow consider this to be preferable to the other mode.

Ladders.—We have now to deal with the ladder. It will be as well for the amateur to have two ladders, one from 10 ft. to 12 ft. in height, the other from 15 ft. to 18 ft. long. These will be long enough for all purposes for which he will require them. The longer ladder, if 18 ft. long, will be long enough to get at a first-floor window comfortably if it be necessary, and this is all the amateur can possibly require. For repairing roofs, etc., ladders of great length are used; but this is dangerous work, and had better be left to those who are accustomed to it.

There is no difficulty in making a ladder. There are two methods, both of which are shown in the the illustrations (Pl. O). The ordinary way is shown in Fig. 5. A fir pole of the requisite length is taken and planed nicely all round. It is then marked along its length in divisions of about 9 inches, the first mark being 9 inches from the end, and the last the same distance from the top, and holes are then bored right through the pole with a ¾ in. or ⅞ in. bit. The pole is then sawn in half from end to end, and some spokes of oak or ash, generally called staves or rounds, thickest in the middle and tapering towards the ends, are driven into the holes in one half of the pole, the flat side being inwards. The staves are a little longer at the bottom than at the

top, so that the ladder may be narrower at the top than at the bottom by an inch, or more if the ladder be a long one. Sometimes an iron bar, as at A, with a shoulder at each end to butt against each side, is inserted instead of a wooden stave, or frequently just below it, and secured with nuts on the outside; one of these is put two or three rounds from the top, and another two or three rounds from the bottom of a long ladder. The other half of the pole is then put on to the other end of the staves and knocked into place. The ends of the staves are sawn close to the pole, if any project beyond the outside surface, and a cut with a chisel is made across each, and a wedge of hard wood driven in. This is shown in the illustration.

Another way of making a ladder is to take two pieces of good red deal about 2½ in. or 3 in. thick and 2 in. wide and nail cleats across, as shown in Fig. 4, the cleats being 2 in. wide and 1 in. thick. They should be nailed on firmly with clasp nails. Some notch the uprights slightly and drop the cleats into the notches, but this tends to weaken the ladder. It is far better to secure a bearing for the cleats by nailing strips of wood to the uprights between the cleats, as shown at A, B, and C by dotted lines.

This, however, tends to render the ladder somewhat cumbersome, and certainly heavier. The method last described is rather a clumsy way of making a ladder, and should only be adopted for ladders of 12 ft. in length and under; for if the uprights be longer they are apt to give under the weight of the person who is upon them, and will sometimes snap asunder, especially when the uprights have been notched to receive the cleats.

Trestles.—When engaged in painting or in putting up a shed in the garden, it will be found inconvenient to be constantly moving steps or ladder from point to point. Supports for a temporary scaffolding will therefore be required, and these the trestles will supply. The trestles, indeed, are likely to be all that the amateur will want by way of making scaffolding, but it will be as well, especially if he be at a distance from a town or wood merchant's yard, to keep a few short scaffold-poles and putlogs in stock as suggested.

A good general idea of the trestle suitable for the amateur may be gained from an inspection of Fig. 6, Pl. O. It is made on precisely the same principle as the sawing stool or mortising trestles used in carpentry. A piece of wood about 2 ft. 8 in. long, or even 3 ft., and about 4 in. square, must be selected for the top; and four legs—B, C, D, E—about 7 ft. or 8 ft. long, and about 4 in. deep

by 3 in. wide, cut at the top so as to receive and hold the piece A. When these have been placed in position and nailed to A, braces or cross-pieces—as shown at F, G, H, K and I, M, N, O—must be nailed to the legs. A pair of trestles of exactly the same size must be made, and it will be obvious to the reader that when a pair of scaffold-boards are placed on the cross-pieces G, K, or M, O, or on the piece A at the top, scaffolding at various heights may be made in a few minutes to suit the convenience of the amateur.

As it may be convenient for the sake of stowing the trestles away to make them so that they may be taken to pieces, it is obvious that it is practicable to make each side of the trestles separately, framing the legs B, E, or C, D together, by cross rails tenoned into them instead of the cross-pieces L, F, or H, N, a third piece being added to connect them at the top and serve as an additional support to the piece A, which will slip into the rectangular opening thus made as into a deep notch. In this case, however, A should be deeper and narrower, so that a bolt may be passed through the framing and A to keep them well together when in use. The pieces G,M, and K, O may be movable, and attached to the framing on either side by bolts passing through the legs, and secured with thumb-screws. These pieces may be wider to admit of two bolts being passed through each end for additional security. When made in this way additional holes may be made in the legs B, E, and C, D, so that the cross pieces G, K, and M, O may be shifted higher or lower as may be necessary.

CHAPTER II

EXCAVATING, AND WHAT IT IMPLIES—TOOLS—CONCRETE, Etc.

Meaning of term "Excavating."—The term "excavating" is applied primarily to all work done in digging out and removing earth, for whatever purpose this may be done. Thus it is applied to the work done in levelling a place for the site of a house or any building, in digging out the trenches required for foundations or for making drains, and in sinking wells.

Although mixing and filling in concrete, burning clay into ballast and making concrete walls cannot be considered as "excavating," yet it is generally entrusted to labourers employed in this kind of work. Making banks and hedges, and planting

them with quickset or other shrubby trees, such as holly, also come within the province of the excavator, as well as the making of embankments or slopes.

Amateur's Work in Excavating.—The amateur's work as an excavator will be confined to levelling ground, digging trenches for foundations, perhaps, once in a way, sinking pits. He will also possibly have occasion to make trenches for draining ground, and will sometimes throw up an embankment or make a hedge. He should also know how to mix and fill in concrete for foundations, and above all other matters, how to make garden walks. We will say a few words on each of these points seriatim.

Scaffold-boards as Temporary Paths.—In all work of this kind, when earth has to be wheeled from one place to another, the amateur will find his scaffold-boards very handy as a temporary path for his barrow to run over. He will also require a spade or a shovel for filling his barrow; a pick for loosening the earth; a crowbar or iron bar for sinking holes in earth, or for splitting asunder hard, close rubbly stone, or any other similar material that he may encounter; and an earth rammer for ramming earth into a hard, solid mass.

Spades and Shovels.—The ordinary form of spade is a broad blade of plate iron, square in form but rather narrower at the bottom than at the top, attached by two long straps of iron springing from upper and under-side to a handle of tough ash, which is shaped something like a shield and pierced for the admission of the fingers. The tools used in draining approximate in form to the common spade. The spade is a short implement, and although excellent for digging and turning over ground, it is by no means as handy for loading a barrow with earth, or throwing earth from one spot to another, or from a higher to a lower position, or *vice versâ*, as the shovel, which is not so familiar an object as the spade. The broad flat blade of the shovel, which may be either square or pointed as may be preferred, has a socket attached to it, into which is thrust a long, slightly bent handle. The length of the handle enables it to be used as a lever in lifting earth, and throwing it into a cart or barrow. The handle is grasped at the top, or near the top, by the right hand, and at about one-third its length from the socket by the left hand. The blade is thrust into the mass of earth, the left hand pressed against the knee as a fulcrum, and the earth, which in this case is the weight to be moved, is raised by a downward pressure of the right hand coming

into play as the power. This cannot be done so well with the spade owing to the shortness of the handle.

The Pick.—The blade of the pick should be of the best wrought-iron, tipped with steel; the handle should be of ash. When the point is driven into the mass that it is desired to loosen, the handle is moved in an upward direction ; and the back of the blade pressing against the earth behind it as a fulcrum, the weight in front of the point is detached and loosened. This implement is a good example of a bent lever. The amateur who requires a pick will often be able to purchase one cheaply at the marine store dealer's.

The Crowbar.—The crowbar is a long iron bar about ¾ in. or 1 in. in diameter, pointed at one end, and beaten into a broad point and slightly bent at the other.

The Rammer.—The earth rammer is a heavy mass of iron with a hole through it into which an ashen pole, about 6 ft. long and 1¼ in. or 1½ in. in diameter, is inserted. When new it is sold by weight, but, like the pick and the crowbar, may often be purchased second-hand. It is one of the most useful aids to work that the amateur can have, for it is constantly in request when posts or wooden uprights of any kind are let into the ground in order to ram tightly together stones, brickbats, earth, gravel, etc., thrown in to fill up the cavity.

Levelling Ground.—The first operation that we may consider is levelling ground, and for the sake of illustration we will imagine that it is desired to make a level platform on slightly rising ground. This is practically the same as levelling a site for a house. The first thing to be done is to take such rough masses or materials as can be got out the higher portion of the ground and pile them in a line along the lower end so as to furnish something in the shape of a containing wall to hold in the earth afterwards thrown into the intervening space. If there be no stones or rough earth that can be utilised, a few rows of short stakes may be driven in to sustain the earth which must be dug out and thrown if the distance be short enough, or wheeled if it be too far to throw, until the hollow has been filled and all the earth removed from the higher portion. As the earth is thrown between the stakes it should be rammed with the rammer to give consistency to it and prevent it from falling out. Of course, as earth occupies more space when loose than when it is solid, when all the soil has been shifted, it will rise above the desired level. It must

however, be left to settle and consolidate. The face of the bank must be made up with some of the earth, and covered with turf; and when the soil has settled sufficiently, trial must be made that the level is true by means of the A level, which has been described in another part of this work (p. 77). In fact, the A level, and the other level for trying uprights, should always find a place among the amateur's building plant.

Trenches for Foundations.—Digging trenches for foundations, and sinking pits for any purpose, whether a cellarage, or a mushroom-house, or any other purpose for which it is necessary to go below the level of the ground, is comparatively simple. The area of the trench or pit must be marked out by stakes driven into the ground at each corner or angle, and the ground within the area thus marked out must be dug out and removed. Care must be taken to keep the sides of the trench perpendicular and the bottom level. This must be done by the aid of the A level and plumb level. The bottom of a trench or pit should be well rammed with a rammer to consolidate the earth, and thus render it better fitted to bear any material, whether concrete or brick, that may be laid in it as foundations for the walls above.

When a trench is dug for concrete it should be exactly the depth and width required for the concrete, but when the foundation is to consist of bricks or stones the trench must be made wide enough to allow room for working, and the space left on either side of the foundations subsequently filled in again with earth. For draining, trenches are made in a different manner, as will be described presently. As trenches are shallow no support is required for the sides, but in sinking a pit in light, loose earth or gravel it may be found necessary to line it with boards to prevent it from falling in. The amateur will seldom, if ever, have to resort to this; and as it will be attended with much trouble and inconvenience owing to the necessity of keeping the boards in place by timbers stretching across the pit, it will be almost better for him to open out the pit very widely indeed at the top, and allow the sides to shelve to the bottom. The walls forming the side of the pit may then be put up in brick, stone, or concrete. If the pit be not of any great size, the struts, usually placed so as to support the boards at the side may also be utilised for the ends, as the boards used for this purpose at the sides being thick will not bend under the weight and pressure of the earth behind them. Of course the boards round the top are placed in position first of all,

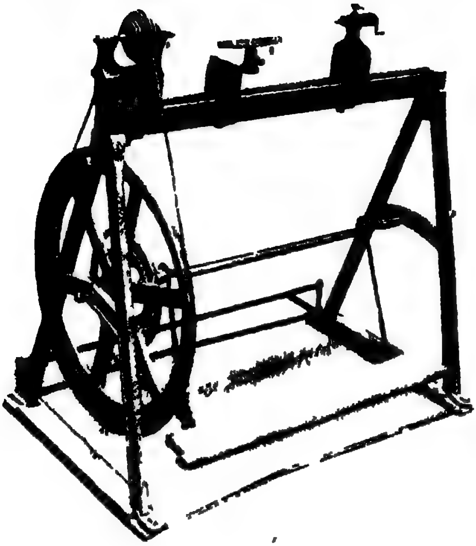
and the remainder in succession as the excavation is carried deeper and deeper.

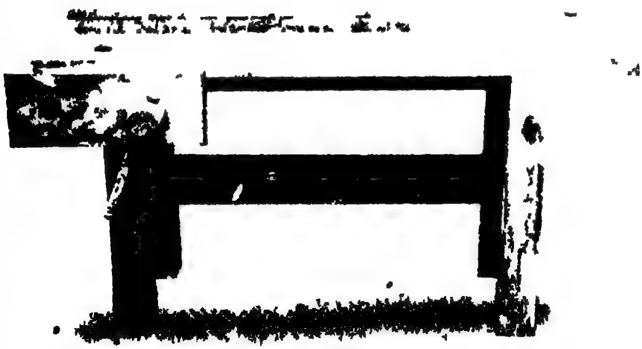
Draining Wet Soil.—When the subsoil is heavy and retentive of moisture, as clay is, it is desirable to relieve the soil above of superfluity of water by draining. The materials employed in covering drains are very varied—brushwood, rubble, stones, bricks, and pipes being all in use. The best and cheapest drains, however, are drainpipes, which are now obtainable everywhere at moderate prices. The implements used in drainage are spades, varying in size so as to go to the bottom of a deep drain without taking out more soil than is necessary, sloping to the point and slightly rounded so as to make a circular cut, a spoon-like implement for lifting the loose soil out of the bottom of the trench, and a level.

Preparation of Trench for Draining.—We will first consider the method of preparing a trench for drainage, and then the different kinds of drains that are in general use. The width at the surface of the drain should be laid out carefully with a line and reel, and the first spit removed of a width in which a man can work conveniently. From this extreme or greatest width at the top the trench will gradually taper towards the bottom, the sides sloping and approaching nearer and nearer until there is only width enough to lay the drain-pipe. If the ground in which the drain is made slopes along the direction of the drain so that one side is lower than the other, the earth as it is removed should be thrown to the lower side; first, because it is easier for the workman, and, secondly, to prevent any slip of the soil that might occur if heavy rains fall while the work is in progress. Having dug out the soil to within 8 in. or 9 in. of the bottom, for which the draining spade is generally used, the bottom being of a width convenient for the workman, the remaining space is required to be much narrower, and is excavated by means of the bottom tools, the workman supporting himself during the work of excavation, on the shoulders or ledges of the trench, the bottom being made smooth and level by means of the scoop, of which several sizes are in use. In making a drain care should be taken that, while the bottom is left smooth, it should have a proper fall in its whole length, and that if there is no natural fall in the land, one should be produced by making the head of the drain shallower than the outfall.

Laying out Drains in Ground. There are various ways of

Plate XXI LATHE AND BENCH

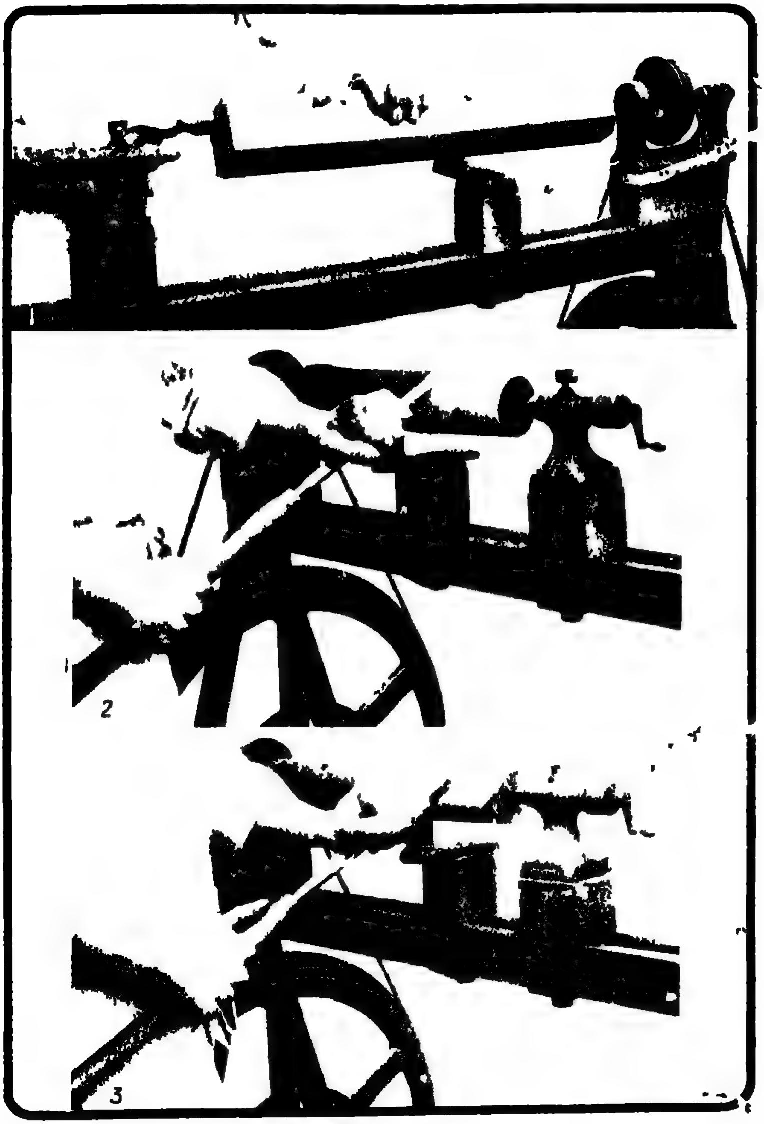




2

1. W[illegible] turn[illegible] lathe 2. C[illegible]p[illegible]nt[illegible]'s b[illegible]n[illegible]h

Plate XXII WOOD TURNING



(1) Chucking the work (2) Roughing down with chisel (3) Manner of holding gouge

laying out the drains in ground, according to the configuration of the surface. If the ground have a uniform slope, as is often the case with garden ground, it will be sufficient to lay parallel lines of 2 in. pipes at a distance of from 15 ft. to 20 ft. apart, provided always that pipes are used in making the drains. When the land slopes slightly on either side to a depression in the middle, a main drain of 3 in. pipes should be laid along this depression from the head to the outfall, and lateral drains of 2 in. pipes entering the main drain and connected with it by junction-sockets and elbow-joints. No precise directions can be given in this matter as the construction and disposition of the drains must in every case depend on the nature of the soil and the contour of the surface. The depth, too, will also depend upon circumstances, but a main drain will vary in depth from 3 ft. to 4 ft., being shallowest at the head and deepest at the outfall. The depth of lateral drains will of course depend upon that of the main drain. All lateral drains should enter a main drain obliquely and not at right angles, and the fall should be greater when the lateral approaches the main drain than at any other portion of its course. From 15 ft. to 20 ft. should be allowed between the feeders to a main drain

Sometimes the drain-pipes are laid with collars, that is, short pieces of piping sufficiently large to receive the ends of two pipes, thus keeping them firmly in their place. In other cases the pipes are joined together by bands of tempered clay, which answers very well, but when this method is adopted the upper sides of the pipes should be perforated with holes for the reception of the water, so that the solid junction of the pipes is no detriment. It is not usual, however, to do more than lay the pipes end to end in a straight line, or just fit the end of one pipe into the socket made for its reception at the end of the pipe that comes next to it, if pipes of this construction are used. In this case no clay or cement must be used to bind the pipes together, but at the junction of any feeder with a main drain the union should be carefully made by clay or cement where permanent drainage is expected.

The following general remarks on drainage and the various methods of constructing drains may prove useful, and afford some useful hints and suggestions to the amateur who may be intending to effect the drainage of his garden or any small piece of ground, either by himself or with the aid of a labourer.

The depth should vary with the nature of the soil. If the subsoil is a stiff retentive clay, care should be taken to go no deeper than is necessary to give the required fall; for water

does not readily filter through clay, and draining land is for the purpose of drawing water quickly off the surface to prevent stagnation and to admit of going on it immediately after rain; therefore to lay drains so deep into the clay that water would be a long time in filtering to them would be useless. If the ground be more porous, let the drains be three, but not more than four, feet deep. Having got the trenches ready, lay the pipes, and cover them for a few inches with rough porous rubbish or broken crockery, or any such material, and the drains will be effective and permanent. An excellent plan is to lay soles or flat tiles, and on these to set half-pipes or bridge-pipes which are of a tunnel shape, and on these to lay the rough stuff and fill in with earth, which should not be rammed or trodden very tight, but merely allowed to settle. If the trenches are merely filled with rough stuff, brickbats, etc., to the thickness of a foot or so, the drainage will be effective but not so permanent; even brushwood will do, and sometimes last for many years in clay soils. When drainage is roughly effected in this manner, the cost of drainpipes is of course saved.

Another form of drain suitable for retentive soils is constructed by placing two stones or tiles against the sides, resting on a third stone, laid on the bottom of the trench. Over these another stone, is laid horizontally, and on this the soil is replaced, the rougher and looser parts being undermost, and in immediate proximity to the stone. A still more perfect drainage is obtained where a circular drain-pipe is laid at the bottom of the trench, which should be carried down into the substratum. Over this pipe are laid, first, the roughest rubble available, on which a slate or tile is placed, which will prevent roots penetrating downwards to the pipes as well as the earth from falling in through the stones. If the pipe rested on the surface of the close tenacious subsoil, the water would be diffused over the surface of the substratum and could not enter the drain-pipe. If, however, the drain-pipe is sunk into the subsoil as it should be, the water trickles from the surface of the substratum first into the rubble and then into the pipe.

In estimating the number of pipes required for a small garden, all that the amateur need do is to measure the length of his drains in feet. He will then require as many pipes as there are feet if he use 12 in. pipes, or four pipes for every 5 ft. if he use 15 in. pipes. He should order a few more than the number actually required to provide against breakages.

Hedges and Embankments.—It is but seldom that the amateur will have to turn his hand to making a hedge. Embankments will be more in his way, in order to obtain variety in his garden, if it be sufficiently large to be laid out with winding walks and diversified by mounds and clumps. A few words on hedges and narrow banks may, however, be desirable.

A narrow bank with steep sides covered with turf, and planted along the top, say, with bush-roses at intervals of about 4 ft., and dwarf plants on either side along the intervals, is always pleasing, either as a border to a lawn or bowling-green, or as a division between one portion of a garden and another. A substratum of rough stuff should be piled on the ground on either side, to afford support to the earth that forms the interior of the mound. Against the exterior, earth should be thrown up and beaten flat with a spade, to afford a better lodgment for the turf, with which the sides must be covered. An angle of 30° will be found convenient for the slope of the sides of such a bank as this, but it may be less if desired. When placed in position, the turf should be well watered and beaten, and then left alone until the grass has rooted into the earth beneath.

Foundation for Quickset-hedge.—In making the foundation or embankment for a quickset-hedge, it is necessary to proceed on a different plan. If rough stones are plentiful in the neighbourhood, and can be procured at a low rate, the space which the hedge is to cover must be marked out, and a V-shaped trench cut out, on the sides of which the stones may be heaped together, sloping inwards on either side, the interstices being filled with earth, well washed in with water, that no space between the stones may remain empty. On this foundation, which may be carried up to the height of 2 ft. or even 3 ft. if necessary, earth may be piled and faced with turf. When the whole has had time to settle and consolidate, quickset or white thorn may be planted along the top of the hedge. If there be no possibility of obtaining stone, or any kind of material that will answer the purpose as well, additional support and strength may be given to the hedge by driving in rough stakes, one row within the other, the stakes of one row being placed opposite the spaces between the stakes in the row before or behind it. The stakes may be from 12 in. to 18 in. apart. Earth should be thrown within the stakes and rammed together somewhat tightly, after which the middle may be filled up, and the bank carred to the height required. The entire surface of a hedge made in this way must be covered with

turf, but when it is constructed with stones, small-leaved ivy, primroses, creeping-jenny, and plants of a similar description may be planted in the interstices, producing a pleasing effect, and in course of time hiding the greater part of the rough stone-work from view. The amateur will find many means and methods of carrying out the mode of construction here described.

Garden Walks and Paths.—We must now pass on to garden walks of different kinds, the making of which comes under the province of the excavator. The chief thing to be done in every case is to provide a solid but yet porous substratum, which will afford sufficient support to the materials of which the upper part of the walk, or rather its surface, is made, and yet allow of the rapid passing away of the water that may fall on the walk in the form of rain. Of course we are now supposing that the walk is to be made in the ordinary way, and coated—if a road, with broken stones, technically called "metalling—" and if a garden path, with gravel.

The course of the path or road must first be marked out with stakes, and the surface soil removed to the depth of 9 in. or a foot if there be no lack of materials to fill it. From one-third to one-half the depth must then be filled up with rough stones, brickbats, clinkers from the brickfields, slag and scoriæ from the iron-works, or any coarse, hard rubbish that can be gathered together; the greater part of the remainder must then be filled up with coarse gravel, shingle, etc., which may be mixed with a little earth to give consistency to the whole, and finally coated with gravel to the depth of two or three inches, which must be constantly rolled with a heavy garden roller until the path is hard and solid.

In some cases it is desirable to have a solid facing to a garden walk so that it may be impervious to rain, and in this case it is of importance that the surface of the walk should be rounded—higher in the centre, and sloping down on either side. The water will escape into the earth or turf by which the walk is bordered, or, if desired, a gutter can be formed to carry the water to a tank formed for its reception in some part of the garden. The gutter may either be moulded in the material of which the path is made or it may be constructed below the surface, like a drain, and hidden from view. In this case catch-pits with iron gratings should be made on each side of the path at distances of about 30 ft. apart.

Asphalte Pavement.—In making a path with a solid surface,

the modes that come best within the compass of the amateur are the two kinds known as tar paving and concrete paving. *Asphalte pavement,* which consists of a surface of asphalte brought to a semi-fluid condition by means of heat and spread over a concrete bed, requires plant in the shape of furnaces, etc., for heating the asphalte, and should be laid by men accustomed to the work. It need not, therefore, be further described.

Tar Pavement.—*Tar pavement,* although making it is a very dirty and unpleasant piece of work, and best left to practised hands, may be easily laid by the amateur. The surface of the walk should be removed to the depth of three or four inches and well beaten. Some thick coal tar should then be poured over a heap of shingle or coarse gravel, and the whole worked together with a spade, or fork, until the gravel is thoroughly mixed with the tar. This composition must be spread over the surface of the walk, and rolled down with a heavy roller. Another mixture must now be made of tar and finer gravel, or sifted ashes from the dustbin, and a thin layer spread over the layer of rougher stuff first put on. Fine sand or gravel must then be sprinkled freely over the top of this, and the whole once more rolled with the roller or beaten flat with the back of the blade of a spade if no roller be available.

Concrete pavement, which is far cleaner to work than tar pavement, is put down in the following manner:—The earth is first taken off the surface of the path to the depth of 8 in. or 9 in., and the shallow trench thus made is filled up to about two-thirds or three-fourths of its whole depth with stones, broken brickbats, and coarse gravel, well rammed together so as to present a level surface. The level for the finished surface having been determined, wooden rules should be laid down about 5 ft. apart with their top edges at the required height. Portland cement must now be mixed in a tub with water until it is of the consistency of thick cream, and poured over the gravel. This must be spread about with a bass broom to level the surface and force it into the interstices of the first rough coat of stones and gravel. On this a coating of Portland cement and gravel, mixed with water, must be spread, bringing the surface very nearly up to the height of the path; and when this has hardened, a finishing coat must be put on; this should be of clean, sharp sand and Portland cement in equal parts, and brought, when mixed with water, to the consistency of mortar. A straight edge should be used at this point to take off the cement

which rises above the rules. The surface must be rounded and brought to smoothness by the aid of a float, a piece of wood with a handle at the back, something like a laundress's iron, but longer, with which plasterers finish the surface of walls and ceilings. As the work proceeds the rules should be removed and the spaces filled up. The surface should be allowed to set perfectly dry and hard before being used.

Concrete.—Concrete, now so much used in forming the foundations of buildings of every description, and even the walls themselves, is a mixture of cement and sand, gravel, broken stones, brick rubbish or similar materials in proportions varying from one part of cement to three parts of other ingredients for good work to one part of cement to twelve of other ingredients for unimportant work. A common mixture consists of one part of cement, 2 parts of sand and 5 parts of gravel, broken stone or brick. Good lime is often used instead of cement, especially for dry foundations. The cement or lime which binds the gravel, or other material together is technically called the *matrix* and the material imbedded in it is called the *aggregate*.

It may be said that any waste material of a hard nature may be used as aggregate in making concrete, sand and gravel of all kinds, including pea or fine gravel, pit gravel, river gravel, Thames ballast and sea beach, burnt clay, broken chalk, ashes, cinders and coke, lime, chippings, flints, old stones and bricks, especially when broken, broken earthenware and stoneware and rubbish from the brickyard may all be used. Slag, too, the refuse of the iron furnaces can be made available whenever it can be obtained. Thus there is no part of Great Britain or Ireland without some kind of material that can be used for concrete. It should not be used in too large sizes. Pieces about the size of stones ordinarily used for metalling and mending roads or such as will pass through a ring of 2 in. in diameter are best suited for the purpose when the material is broken up for the purpose of making concrete.

Any of the various cements in general use may be used in the manufacture of concrete, but the amateur is recommended in all cases to use Portland cement, this being by far the best and strongest. If lime is used it should be carefully slaked before being mixed with the aggregate. All lumps should be broken, and enough water added to reduce them to powder. After being allowed to stand for forty-eight hours the slaked lime should be passed through a screen.

In making concrete, it is important, in the first place, that the aggregate, be it what it may, should be deposited on a clean place—if on old boards, as scaffold boards, so much the better—so that no dirt may get mixed up with it. The concrete itself should be made on boards, nailed together on ledges or on three putlogs placed on the ground parallel to one another, forming a rough platform. The aggregate and the cement or lime used as the matrix must then be placed on the boards, the aggregate being measured out first, and the proper proportion of cement being also measured out and thrown upon it. Whilst still in the dry state, the materials should be turned over two or three times. The heap is then wetted with water poured over it from a large water-pot fitted with a fine rose, and the whole is mixed by again turning it over once or twice, so that the materials may be thoroughly amalgamated.

The principal precautions to be taken in the process of mixing are :—

(1) The water should be added to that portion of the material which the "shoveller" is working upon and not to the mass indiscriminately, as this allows the cement to sink through the interstices of the aggregate before attaining partial solidity.

(2) The full quantity of water should be added during the third turning, not afterwards.

(3) The quantity of water applied must be regulated according to the purpose for which the concrete is intended. For foundations, arches, etc., only as much as to cause slight cohesion between the materials is necessary; but for walls, between frames, and in similar work, it must be in ak ind of semi-liquid condition.

(4) The "shoveller" must turn the concrete completely over when in the act of casting it from one heap to another—not take it up in the shovel—and deposit it without changing the position of the ingredients."

When using quick-setting Portland cement no time must be lost between the operations of mixing and depositing the concrete where it is required.

In filling a trench with concrete in order to serve as the foundation for brick or stone work, or even for a concrete wall, it is necessary that the concrete should be thrown into the place in which it is to be with some degree of force. To ensure this in laying the foundations of houses, the concrete was formerly thrown into its resting-place from a stage raised from 6 ft. to 8 ft. above the level of the ground. This was done in order

to give solidity to the mass, and to cause the wet conglomeration of cement and gravel to lie closer together than if it were merely shovelled into the trench from the level of the ground itself.

The objection to this method is that the heavy and light portions of the material separate while falling and the concrete is not uniform throughout its mass. In modern practice the concrete after being mixed is at once wheeled to the place where it is to be laid and tipped or thrown through a height of not more than three feet into position. It is then carefully rammed in layers about 12 in. thick. Each layer, which should be made perfectly level, must be allowed to set before the next layer is added. The surface should in all cases be prepared for the new layer by roughing it up with the pick and wetting it. It must always be remembered that it is extremely important that joints in concrete should be properly made, as unless precautions are taken they will always be a source of weakness. If there is not time to allow each layer to set the new layers may be added immediately after the ramming, but on no account should any ramming be done after any of the layers have commenced to set. Constructional work in concrete is dealt with in a later chapter (see pp. 366–9).

To go further into details respecting the various kinds of work performed by the excavator is not possible on account of the want of space, and the number and variety of subjects in connexion with the building art yet to be considered. It is, moreover, unnecessary, as our object is not to write an exhaustive work on building processes, which would, if properly treated, assume the form and extent of an encyclopædia, but merely to bring under the notice of the amateur artisan such work as he may be able to accomplish himself without aid from others.

CHAPTER III

BRICKLAYING, ITS VARIOUS BRANCHES: TOOLS, PROCESSES, ETC.

Bricklaying.—Bricklaying is in itself an apparently simple process, inasmuch as it consists merely in laying or disposing regular and similar rectangular pieces of baked clay one upon another, layer upon layer, until a certain height is reached, spreading between each layer a composition of lime and sand called mortar which hardens and connects the bricks together in a

solid mass. There is, however, much more skill in bricklaying than is apparent at first sight, and really good bricklaying, like many other building processes, cannot be done without practice.

In the first place it is necessary to determine that the surface, whether of earth or concrete, on which the superstructure of bricks is to be reared, is perfectly level, as, if this be not the case, it cannot be expected that the courses of bricks will be in regular lines. Attempts will be made to overcome this by making the layers of mortar thicker in one part than another in order to bring the courses level; but such a mode of proceeding as this will be found objectionable and detrimental to the solidity as well as the appearance of the wall, because if the mortar could be preserved in its extra thickness in parts it would present a large breadth to be acted on by the weather, and the actual experience of the builder of the wall would be that, as additional weight was imposed on the soft mass by each additional course of bricks, it would shrink and cause irregularity in the upper courses.

Thus much for the wall in its length. It is also clear that a want of due level in the surface on which the wall is built cannot fail to cause it to incline to one side or the other, while it is absolutely necessary that the inner and outer face of a wall should be perpendicular or at right angles to the plane surface on which it is raised.

It is almost unnecessary to observe, after what has been said in the preceding chapter about clearing trenches for foundations, that the level of the surface on which a wall is built must be ascertained by means of the A level, and the accuracy of the perpendicular of the wall by the upright level or plumb.

Bricklayer's Tools and Appliances.—The tools required in bricklaying are a large strong steel trowel, with which mortar may be spread and bricks chopped asunder or reduced to any extent that may be required in order to produce a perfect bond. Mortar is carried up the ladder, and on to the part of the scaffolding where the bricklayer is at work, by his attendant labourer, in a hod, which is shaped like a box, open at one end and cut across diagonally and fitted at the bottom angle into a short pole. The amateur will not want an appliance of this kind, as he will not attempt to carry a wall to any height. He will, however, want a small trowel for pointing, and a piece of wood about 10 in. or 12 in. square, fixed on a wooden peg which serves as a handle by which to hold it.

With the exception of a piece of boarding, consisting of boards about 1 in. thick, nailed on to ledges on which to mix mortar close to the scene of operation, and on which to carry it thither from the main mass, everything which is necessary to bring under the reader's notice respecting the use of the necessary appliances has been said already. The large trowel must be of steel, and ring clear and resonant as a bell when a brick is struck with it. A small trowel will be required for pointing or filling the spaces between the bricks with new mortar or even cement. The mortar-board on which the mortar or cement is placed, is held in the left hand by the handle below while pointing. The mortar-board the amateur can make for himself. It is simply a square piece of inch board fitted with a handle, which may be cut from an old broomstick, though a piece of ash is better. It should be keyed and wedged into the board and strengthened by means of angle irons or small brackets.

Foundations.—When the earth under the proposed foundations has been well rammed so as to impart the necessary degree of solidity to it, or that a substratum of concrete has been laid, and that it has been ascertained that the earth or concrete, as the case may be, is perfectly level, the foundations of the wall may be laid. It is unfortunately too often the habit to use the worst possible description of bricks for the foundations. The amateur must take care to see that he has sound, hard, strong bricks for this purpose. Bricks that are rough and unfit for the upper part of the wall are good enough for the foundation as long as they are moderately square and hard, and therefore all the less likely to soak up water.

Thickness of Walls.—It will be clear even to a novice that the foundation of a brick wall must exceed the thickness of the wall itself in all the courses, from the lowest to that from which the wall springs. The thickness of a wall is described by the number of bricks or parts of bricks to which it extends. Thus a partition wall in brick nogging, or of the *breadth* of a brick, is described as being half a brick thick, and the extent of thickness ranges upwards from this, as one brick thick, one and a half bricks thick, two bricks thick, two and a half bricks thick, three bricks thick, etc. Now a brick is accounted to be 9 in. long, 4½ in. broad, and 2½ in. thick, the breadth being half the length, and the thickness rather more than half the breadth, or one-fourth the length; an arrangement which renders bricks more con-

venient to use owing to the correspondence of proportions in length, breadth, and thickness. The equivalents of the thicknesses of walls above enumerated will therefore be, when expressed in inches, ½ brick = 4½ in.; 1 brick = 9 in.; 1½ bricks = 13½ in.; 2 bricks = 18 in.; 2½ bricks = 22½ in., etc.

Measurement of Brick-work.—Before proceeding any further it may be desirable to say something about the measurement of brick-work, and the space that a certain number of bricks will fill when built together.

A rod of brick-work is 272 ft. superficial, 1½ brick or 13½ in. thick, called in London the standard thickness, to which all brick-work of whatever thickness is reduced. One rod of reduced brick-work is equal to 306 cubic feet or 11⅓ cubic yards. To one rod reduced 4,352 stock-bricks are reckoned, and 4 courses of bricks are estimated to make 1 foot of brick-work in height. When laid dry—that is, without mortar—it takes 5,371 bricks to one rod, and 4,900 bricks in wells and similar circular work. These calculations are without allowing any waste, which is more than amply compensated in dwelling-houses by not deducting flues and bond timbers; in such work 4,300 stock-bricks, or 4,500 place-bricks are sufficient for a rod. A rod of brick-work contains 235 ft. cube of bricks, and 71 ft. of mortar (4 courses to 1 ft.), which will weigh on an average calculation 15 tons. It takes 16 bricks to make a foot cube of reduced brick-work, and 7 bricks to form a foot super of facing. One yard of brick nogging takes 30 bricks on edge, and 45 bricks flat, but one yard of paving requires 36 stock-bricks laid flat or 52 on edge. If paving bricks are used, which are thinner than the ordinary brick, 36 are required when laid flat, and 82 when laid on edge.

Mortar.—Bricks are cemented together with mortar, which is a mixture of lime and sand brought to a pasty consistence by the addition of water. The quality of mortar depends upon that of the materials used in its manufacture, their treatment and proportions and the method of mixing them. Lime, as used for building purposes, is obtained from several of the varieties of stone, marble, and chalk, termed limestones. It is prepared by burning or calcining the stone, thus drawing off the carbonic acid in which it abounds. After calcination it is reduced to a white powdery material, which greedily takes up water; it is then known as *quick lime*. In making mortar, fresh burned lime is taken from the kiln, and lain in a heap in a convenient place. When water is sprinkled on it, the lime begins immediately

to crack and fall down, steam issuing from the heap in considerable quantities—a high degree of heat being at the same time induced. On the completion of the process of decomposition, the lime is reduced to an impalpable powder, which goes by the name of "slacked or slaked lime." In mortar for important work hydraulic lime or cement should be used; the cheaper "fat" limes should only be allowed for inferior or temporary work. The sand used in mortar-making is of three kinds—pit sand, river, and sea. The sea sand should never be used if it can be at all avoided, as walls built with mortar prepared from it are very likely to be damp. The purpose of sand in mortar is merely to save expense and to prevent excessive shrinkage. The quality of the sand, is, however, of considerable importance. It should be clean and sharp and quite free from all impurities. The water used for mixing mortar should be free from mud, clay or organic matter. Salt water should not be used with pure limes or in dry situations as it induces damp and efflorescence, but in the case of hydraulic limes and cements it is sometimes advantageous to use it, as the moisture attracted by the salt prevents them from drying too quickly.

The slaking of the lime should be done on a wooden or stone floor under cover. After the lime has been sprinkled it should be covered over with the actual amount of sand which is afterwards to be mixed in the mortar. In this way the heat and moisture will be retained, and the slaking will be more rapid and thorough. The usual time required for the process of slaking is 24 hours, but this will vary with the hydraulic properties of the lime. The quantity of water required for slaking also varies with the quality of the lime, but it is generally rather more than one-third of its bulk.

In order to thoroughly incorporate the ingredients of the mortar, the heap of slaked lime covered with sand is carefully turned over two or three times with the shovel whilst still dry. Afterwards it should be formed into a ring into which the required quantity of water should be poured, and the whole turned over two or three times and well mixed, the consistency, as already indicated, being finally that of a creamy paste.

When it is desired to make brick-work as strong and durable as possible, the mortar should be made of cement, or a little cement should be added to the lime. Lime and sand, and cement and sand, lose about one-third their bulk when made into mortar, and lime and Portland cement both require one-third their bulk of water to mix. For a rod of brick-work, 71 cubic feet of

mortar will be required, as it has been said, and to make this quantity are required 1½ cubic yards of chalk lime, and 3 of road drift or sand; or 1 cubic yard of stone lime, and 3½ of sand. With Portland cement some three or four parts of sand are mixed. From this it is apparent that the proportion of mortar or cement when made up, to the lime or cement and sand before made up, is 2 to 3.

Brick-work: How to Calculate Cost of.—The cost of brick-work may be easily calculated from the above memoranda. There are many different kinds of bricks variously named from their colour or quality, or the place where they are made, but the two kinds most generally used by the amateur in such work as he may do are commonly known as place-bricks and stock-bricks. Bricks are sold by the 1000. A variation in the prices is made according to the greater or less distance that the bricks have to be carted from the place where they are made to the place where they are to be used. When an old brick building has been taken down, the amateur may buy very good bricks for his purpose at a low rate, and in the vicinity of most large towns there are certain places which may be found out by a little inquiry, where these and other component parts of houses that have been pulled down may be obtained.

Bricks.—There are many different kinds of bricks which may, however, be divided into three classes, as follows:—1. Bricks used for walling; 2. Fire-bricks, and 3. Clinkers or Paving-bricks. There are two methods of burning bricks for walling, and the bricks are accordingly called "kiln-burnt bricks" and "clamp-burnt bricks;" the former being baked in a kiln and the latter burnt in a huge stack or *clamp*, containing from 500,000 to 1,000,000 piled together in a square or rectangular mass with fuel in the form of cinder ashes or breeze scattered between the layers. About one-tenth of every clamp is lost by the unequal action of the fire and breakage. When the clamp is sufficiently baked, the bricks are sorted into classes known as *cutters*, fine close-grained bricks, rather soft and better suited for work in which the bricks require cutting; *picked stocks*, or bricks of a uniform tint; *paviours*, or hard bricks fit for paving; *common stocks*, or ordinary bricks; *grizzles*, or *soft bricks*; and *burrs*. The bricks also vary in colour according to the degree of heat to which they have been exposed. The kiln-baked bricks, also called *malms*, are made of a finer clay, and slowly burnt in kilns. They are of a pretty buff colour and uniform in tint, but they are not so

durable as the common bricks. Their colour is due to the quantity of carbonate of lime that they contain, and it is this ingredient that renders the Suffolk bricks so pale, indeed, almost white, in colour. The fine red bricks made in the Midland counties are chiefly used for the better class of buildings, or for arches over doors and windows, in which the bricks must be gauged or brought down by rubbing so as to fit together at certain angles. Fire-bricks and paving-bricks also are made of clay, which contains a great quantity of silicate of alumina and but a very small proportion of lime or iron. The silicate of alumina fuses when the bricks are burnt, and this causes them to become very hard and durable.

Rule in Bricklaying.—To proceed, however, with bricklaying or building with bricks, the amateur must remember that it is a fundamental rule that *in no two courses of bricks immediately continuous shall the joints between two bricks in each course be continuous or form a straight, unbroken line.* This must be rigidly observed; the disposition of the bricks caused by the observance of this rule is called "breaking bond." A layer of bricks throughout a wall is called a "course," and when bricks are so laid that their length is in the direction of the course, and their sides appear in the face of the wall, they are called "stretchers," and a course thus formed a "stretching course;" but when they are laid across the line of the course so that their ends or heads appear in the face of the wall, they are called "headers," and a course thus laid is called a "heading course."

Bonds used by Bricklayers.—There are two kinds of bonds commonly used by English bricklayers, called respectively, "English bond," and "Flemish bond," and of these the latter is the more generally used. "Herring bond," is only used for the core or interior of walls faced with Flemish bond, and is formed by laying bricks diagonally between the faces and filling the interstices with mortar. It is a very weak mode of building, for the faces of the wall are not connected by bricks running transversely to the length of the wall, having their heads or ends in one face or the other, or in both if the wall be one brick or 9 in. thick. "Garden wall bond" is only used for 9 in. walls, and consists of courses of three stretchers and one header in regular succession throughout the course. English bond consists of alternate courses of stretchers and headers as shown in Pl. P, Fig. 1. It is reputed to be the strongest bond used in bricklaying; but it is not so ornamental, and therefore pleasing to the eye, as the

Flemish bond, shown in Fig. 2, which consists of courses composed of headers and stretchers in alternation, every successive course being so arranged that the header in the course above rests immediately on the middle of the stretcher in the course below, while the stretcher in the upper course extends over the header in the course below it, and has its ends resting on the ends of the stretchers on either side of the header in question. The difference in the appearance of English and Flemish bond is clearly shown in the illustrations.

Important Points in Bricklaying.—Having seen the general disposition of bricks in the face of a wall, there are yet certain points to be considered, and these may be summarized as the method adopted by the bricklayer in building a wall; the use and object of the "closer"; the manner in which successive courses of bricks are laid one upon another in building a brick wall; the construction of the quoin or corner when two walls are built at right angles to one another; and, lastly, the method of forming a reveal where the wall is interrupted in its regular course by openings for doors and windows.

Method of Building Walls.—In dealing with the general method of building a brick wall we may for the present omit any reference to bonding so as to render the process as intelligible as possible by describing it step by step.

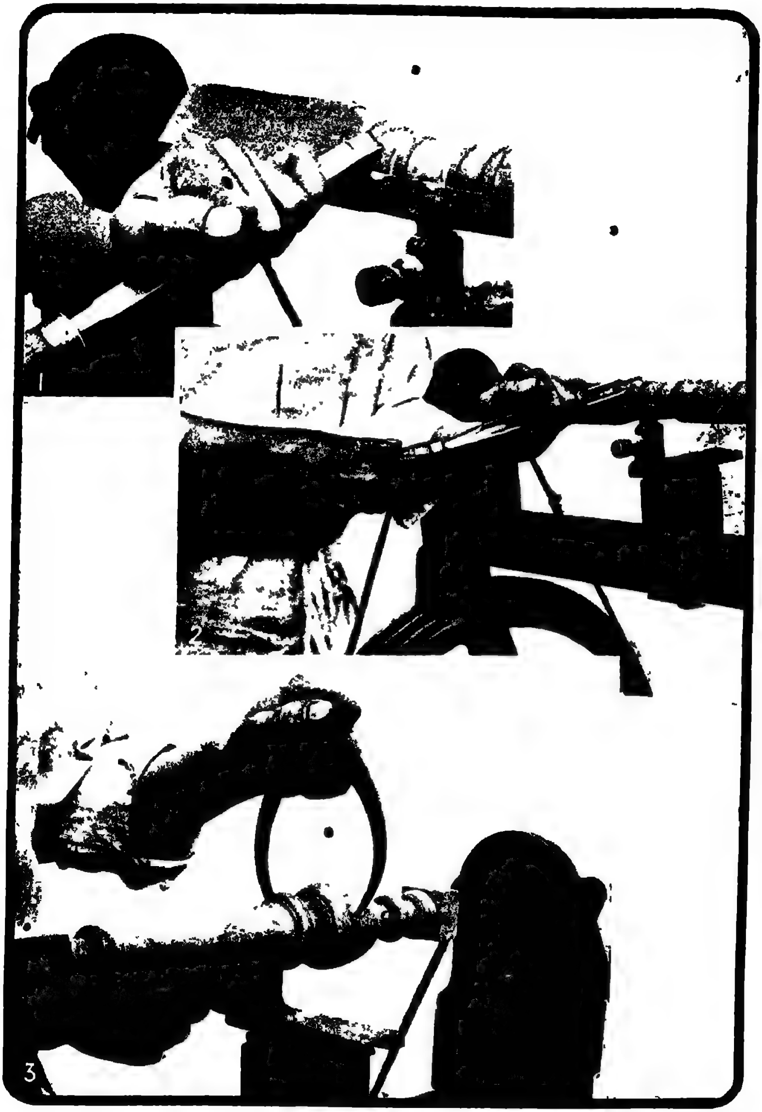
Two courses of bricks above the level of the ground having been duly laid, as shown in Fig. 3, Pl. P, the bricklayer then proceeds to build up four or five courses at each end of the wall, seeing by means of his level that the bricks are laid level, and that their outer faces are perpendicular. He then stretches a line A B along the length of the wall from A to B securing it to the ends of the wall that he has just put up by means of two iron pegs furnished with the blades something like that of a dinner-knife, the flat part being thrust between the bricks and the peg projecting as at C, D, and furnishing a kind of spindle by which the string is stretched, and on which any surplus length is wound. It will be necessary for the amateur to have a pair of these. Two purposes are served by stretching the line; the topmost course of bricks are by its aid brought level with the bricks at A and B at either end, and by looking downwards and bringing the line directly over the edge of the bricks, he is assisted in making his wall truly upright or perpendicular. In laying bricks some mortar is first spread on the surface of the last course of bricks laid; the brick to be placed in position is

carefully brought to the brick last laid, a little mortar having been thrown in with the trowel to cement end to end. Every brick should be rubbed and pressed down in such a manner as to force the mortar into the pores of the brick, and so produce a perfect adhesion. Moreover, each brick should be made damp or even wet before it is laid, as otherwise it absorbs the moisture of the mortar, and its surface being covered with dry dust and its pores full of air, no adhesion can take place. The bricks should therefore be dipped in water just before being laid, and the upper surface of each course should be moistened by means of a watering-pot with a fine rose, before the next course is laid. When using quick-setting cements this is particularly important, as unless the bricks are quite wet the cement will not attach itself at all. When placing the brick in position, pressure is exerted until sufficient mortar has been squeezed out below to bring its upper surface on a level with that of its neighbour, the operation being completed with one or two slight blows from the butt end of the trowel handle, the trowel itself being held in an upright position.

Closers: their Use in Bricklaying.—It by no means follows that the length of a brick wall is the exact multiple of that of a brick, that is to say, that the wall contains an exact number of bricks in its length. It is to remedy any inconvenience resulting from this that a portion of a brick called a "closer" is used; the closer also further serves as an aid in breaking bond. As a practical example of the use of the closer, and the way in which successive courses of bricks are laid, let us consider two courses of a 9 in. wall in Flemish bond, which in all probability will be the utmost thickness to which the amateur bricklayer will extend his operations; these being limited perhaps to a 4½ in. wall for a small greenhouse, or a 9 in. wall for a larger greenhouse or shed.

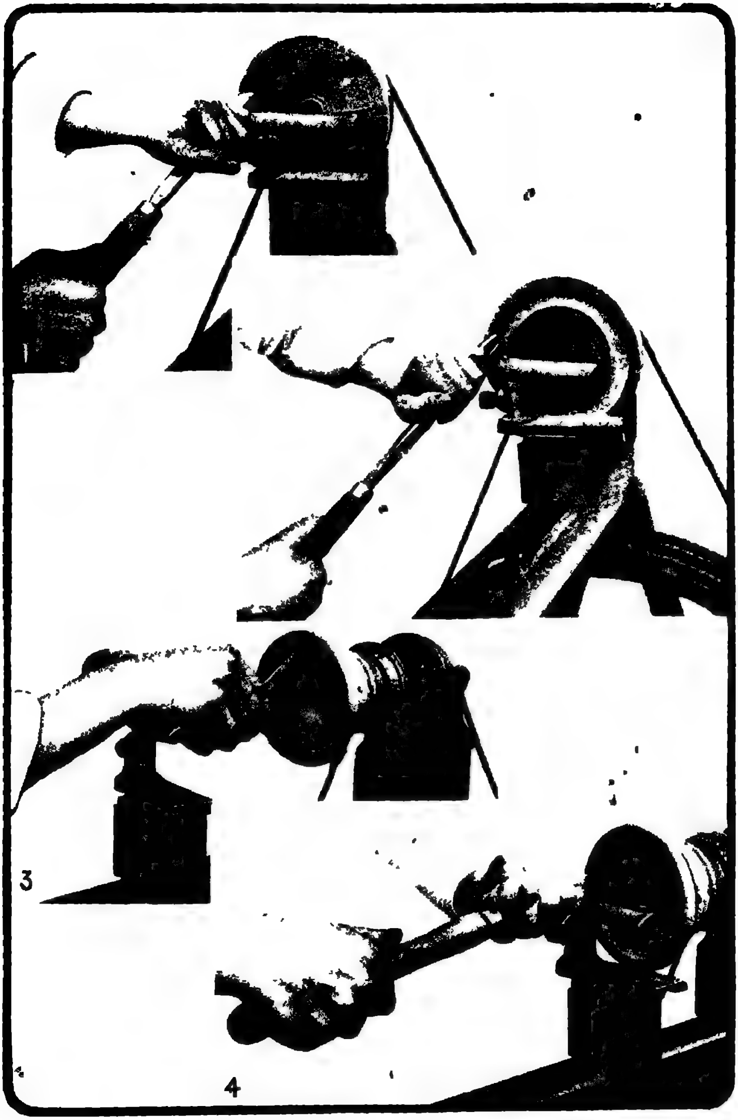
The use and purpose of the closer, and the manner of laying successive courses of bricks in a 9 in. wall, Flemish bond, are illustrated in Fig. 4. In the middle portion of this figure, the elevation or appearance of the exterior face of the wall is represented, and in this case the interior face will be similar to the outer face. In the upper portion is represented the plan of the course A, and consequently that of C; while in the lower portion is represented the plan of the course D, and consequently that of B. These figures, in fact, are the plans of the alternate courses of bricks from the bottom of the wall to the top. Now to any one who will examine

Plate XXIII —WOOD-TURNING



(1) Manner of holding chisel, (2) Use of gouge, (3) Testing with outside callipers.

Plate XXIV—WOOD-TURNING



(1) Facing up ; (2) Position of gouge for hollowing ; (3) Use of inside callipers ; (4) Deep hollowing

these figures carefully, connected as they are by dotted lines, it will be manifest that, if the courses A and C had had a stretcher placed next to the header with which they are commenced, and the courses B, D, had had a header placed next to the stretcher with which they are begun, the ends of the stretchers and the sides of the headers thus placed would have formed a perpendicular line in the face of the wall, thus breaking at the outset the fundamental rule in bricklaying, that the line of junction between two bricks in any course shall never be in the same straight line with the junction of two bricks in the course immediately above or immediately below it. To bring everything into fitting order the bricklayer has to cut a brick in half lengthwise, and this half-brick is inserted, as shown at E, between the header F and the stretchers G, G. A regular continuance of headers and stretchers can then be laid in the courses A and C, a rectification of breaking bond having been effected by the insertion of the closer E which closes up the space that otherwise would be open, and renders the wall solid throughout. It is evident also that to bring all things right, closers must be inserted at the other end of the courses B and D, between the last stretcher and the last header. This the reader may easily work out for himself by continuing the drawing on paper, and finishing up the end in the same manner as that which is shown to the right of the middle portion of the figure.

Formation of Quoin or Angle.—Next in order it is necessary to give attention to the formation of a quoin or angle formed by the exterior and interior faces of a wall at right angles to each other. This will be best done by considering the appearance of the ends and sides of the bricks in the accompanying plans of courses in Fig. 4; turning the corner marked A B C D, and seeing what plan must be adopted so that the courses of bricks in each part of the wall meeting and joining at right angles in the corner may be firmly and securely bonded together.

If the wall described were simply a wall built in a straight line and finished off clean and perpendicular at either end, it is clear from a consideration of the figures just mentioned, that the end of the wall being 9 in. or one brick thick would present the appearance shown in the middle portion of Fig. 5, which is the elevation of the end of the wall, and the upper and lower portion of the figure, which are the plans of the courses A, C and B, D respectively. Now the corner or quoin must be turned in such a manner that the ends of the

stretchers A and C in the courses thus lettered will enter the new part of the wall, and that the ends of the first stretcher laid in the courses B and D shall enter the portion of the wall that is at right angles to the new part. The manner in which this is done is clear from the figures in illustration, remembering always the manner in which regularity of bond was preserved in the other face of the wall. Instead of the stretchers H, K, shown in Fig. 5, closers L and M must be substituted, and the wall carried on with regular succession of stretchers and headers in courses B and D, and headers and stretchers in courses A and C, until the end of the wall is reached, when courses A and C must be completed by the introduction of closers. The shaded portion of the stretchers next to, and butting against, the closer M shows the extent to which the tie is carried.

In the course of a few brief sections it is impossible to give anything like a complete exposition of the mode adopted by bricklayers in laying bricks and connecting walls at right angles to each other. It is hoped, however, that what has been said on the subject is at least clear, and will prove sufficient for all practical purposes for the amateur.

The Reveal in Brickwork.—We have now to consider the formation of the reveal, the term applied in architecture to the side of an opening for a window, doorway, or the like, between the framework and the outer surface of the wall. The appearance of the reveal from the outer to the inner face of the wall is in reality a rebate in brick-work, the framing of the window or that to which a door is hung fitting into the rebate.

In actual building the frame for a door, provided that it be an outer door of the house, is fixed in position, and the bricks are built up to the wood-work, completely encompassing it, as it were; but the sash-frames of windows are not put in until the wall is built. In building a 4½ in. wall the frame for the door is set up in position and the bricks built up to it and by it, the inner surface of the brick-work being flush with the inner part of the frame, while the outer surface generally projects a little way beyond it. Thus in a 4½ in. brick wall, built round a door-frame 3 in. thick, the inner surfaces of brick-work and frame being flush one with another, it is clear that the outer face of the brick-work would project 1½ in. beyond the outer face of the frame. The construction of a reveal, and the manner in which it is made, is shown in Pl. P, Fig. 6, in which the angle or recess into which a wooden framing may be fitted, whether it be a door-frame or sash-frame, is

clearly shown. After all that has been said about the use of closers, it will be unnecessary to go into any detailed description. The closure at the reveal should be a bond closure. Thus supposing A and A to be whole bricks in the courses to which they belong, the wall being a 9 in. wall in Flemish bond, B will be the bond closures, extending in their several courses from the outer to the inner face of the wall, and C, the half-brick completing the impost of the reveal. The face of the reveal is formed by the ends of the whole bricks and half-bricks in succession, and the face of the rebate or retiring portion by the bond closures and half-bricks inserted between each to make fair. Some bricklayers will use a three-quarter brick in place of the half-brick C and bond closer B, but if this were done it is manifest that there would be no bond from top to bottom.

Opening for Door or Window.—Having formed an opening in a brick wall for a door or window, as the case may be, the next thing to be considered is how to bridge over the opening so that, if necessary, the wall may be continued above it throughout its entire length. The simplest method that the amateur can adopt is to lay a piece of wood of the thickness of one or two bricks, according to the length to be bridged over, and the extent of walling that is to be raised above it, from pier to pier, and proceed to enclose it and build over it with bricks, taking care that the timber used is of such a length that the breaking bond throughout the wall may be properly observed. The method of doing this is shown in Pl. XXVIII, Fig. 1.

The Brestsummer.—This mode of procedure is adopted in building in providing a resting-place, at once strong and sufficiently rigid to prevent any sagging in the middle, for the superincumbent weight of the wall that is piled above it, in the case of shop-fronts and projecting bay windows, when the width of the opening to be bridged over is considerable. The beam, or brestsummer as it is technically called, is hidden from view by the facia of the shop-front, or by the roof or covering of the bay window, and so any unsightliness of appearance is avoided; but in house-building, if a piece of wood were left showing in the wall it would look very ugly. To prevent this the space over a door or window is usually bridged over by a lintel in stone or an arch in brick. The stone lintel is merely a repetition of the timber in a different material, but some skill has to be exhibited in forming the arch in brick. There are many forms of arches used in building, according to the style of the work

in progress, but for these and their construction the reader is referred to any standard work on architecture.

Stove in Workshop.—It is possible that the amateur may at one time or another desire to construct a small stove in a workshop, with a chimney to carry off the smoke, or even to make flues in walls, for the conveyance of hot air or to allow of the escape of smoke. Of course the thicker the wall the easier it is to make a flue, or horizontal or vertical passage, through it, as the case may be; but this may be done without difficulty even in a 9 in. wall. A knowledge of the method may prove useful in the construction of forcing pits, greenhouses, and fowl-houses.

Horizontal Flue.—We may suppose, for example, that it is desired to construct one or more horizontal flues in a brick wall. In such a case it is manifest that Flemish bond will not do, because the headers in each course would prove an obstruction. English bond must therefore be resorted to, which, as the reader will remember, consists of alternate courses of stretchers and headers. The wall must be built up in the ordinary manner, a layer of stretchers and a layer of headers alternately, until the height is reached at which it is proposed to construct the flue. The last course laid—which, it must be observed, forms the bottom of the flue—must be a course of headers. On either side of this course of headers a line of stretchers laid on their sides, is placed, and as a brick is 9 in. long and $2\frac{1}{2}$ in. thick, a longitudinal opening 4 in. wide and $4\frac{1}{2}$ in. high, is left in the centre of the wall. This opening is covered in by another course of headers, on which the wall is continued with a course of stretchers, and so on.

If bricks are scarce and expensive in the locality in which the amateur lives a saving of about one-third might be effected by building the wall from the level of the ground with alternate courses of headers and stretchers laid on their sides. The wall would not be so strong, it is true, as a solid 9 in. wall, but if solidity were a *sine qua non* it might be gained by filling the hollow with gravel concrete.

Bricks, Porosity of.—Bricks are very porous, and will absorb a considerable quantity of water. It is frequently stated in text books that a good brick should not absorb more than $\frac{1}{15}$ of its weight in water. As a matter of fact, however, the absorption of average bricks is about $\frac{1}{6}$ of their weight, and it is only very highly vitrified bricks that take up so little as $\frac{1}{15}$. The absorbent

powers of any bricks may be tried by allowing them to remain for some time in a bucket or half-cask containing water, and noting their weight before and after immersion. It is the porosity of bricks that so frequently renders a house damp on the side most exposed to rain, and which causes a wall to remain damp for so long a time when the bricks have become thoroughly saturated by the overflow of a gutter used to carry water from the roof, or the bursting of a pipe.

Bricks will also become damp by capillary attraction ; that is to say, when bricks are laid on damp ground, or ground which is nearly always in this condition, the water will rise through the pores of the bricks, extending upwards from course to course until a considerable space of walling is affected by it to the detriment of plastering and paper within.

Damp in Wall, Prevention of.—There are two things which manifestly require the attention of the amateur. First, how to prevent water from rising in a brick wall, especially if the wall in question forms part of a building erected as a workshop, or for some similar purpose ; and, secondly, how to prevent the further rising of damp in a wall that has been built, and to counteract the bad appearance and ill effects resulting from its presence.

Damp Courses of Various Kinds.—The rising of damp in brick walls, or any tendency to this, can only be effectually stopped by the insertion of what is technically called a " damp course " in the wall, about the thickness of a brick *above* the ground line, or the line where the earth comes in contact with the brick-work. A damp course *below* the earth line is not so effective, because the bricks above it will absorb water, though not to so great a degree, from the earth that may be in contact with them. A simple and effectual damp course is one of slate, laid right through the wall as soon as it has been brought about a brick's thickness, or, in other words, 3 in. above the ground line. The slates should be laid in Portland cement, and it is as well to lay two or three courses of bricks immediately above the damp course in Portland cement also. Asphalte is sometimes used ; this is cheap and effective, but almost beyond the management of the amateur ; and damp courses are made in glazed earthenware, pierced to allow of ventilation. Water cannot make its way through slate, asphalte, or glazed earthenware, hence the fitness of these materials for a damp course.

To cure dampness in a brick wall is far more difficult than to take proper means at the outset to prevent its appearance.

If a house shows damp on all sides just where the walls rise from the ground, the only effectual cure is the insertion of a damp course just above the ground line. This can be done by degrees, and although productive of much dirt and discomfort while the work is in progress, it can be effected without any danger to the stability of the building as the course of bricks taken out for the insertion of the damp course can be removed by degrees, and replaced immediately by the damp course as the work goes on. Such an operation can, of course, be carried out only by a professional builder. It will be understood that reference is made to these matters, not with any idea that the amateur artisan can do any work of the kind himself, but that it is well that he should know the extent of the work involved in remedying such a serious defect.

Damp in Upper Part of House.—If damp has been caused in the upper part of a house through the breakage of a water-pipe, or the stoppage of a gutter or waste-pipe, the first thing to be done is to remedy the primary cause of the evil. The overflow of water in rain-water pipes and guttering is often caused by the presence of dead leaves or a bird's nest, which prevents the escape of water through the proper channel, and for this reason it is desirable to have the guttering and heads of all pipes inspected and cleared once a year.

Although in a short time the plastering may become dry in appearance, it may yet be sufficiently damp to destroy any paper that may be pasted over it. Sometimes an under coating of pitch-paper or other waterproof paper, is applied to the wet surface, and the wall-paper is pasted on this; but the waterproof papers do not always answer the end for which they are specially intended, and probably nothing better or more effectual can be found than a solution of shell-lac and naphtha, in the proportion of about four ounces of the former to a quart of the latter. This solution, when applied to the damp surface of the plaster, almost immediately hardens into a varnish impervious to water, and as soon as it is hard and dry, the wall-paper may be pasted to it. It gives a reddish colour to the wall, but this matters little, as it is covered over by the paper. The smell of the naphtha is most unpleasant, but, fortunately, it soon passes off. This kind of work any amateur artisan ought to be able to do.

Damp-proof Coating for Brick-work.—The following remedy for damp walls is often recommended as being effective :—

Three quarters of a pound of mottled soap is dissolved in one gallon of boiling water, and the hot solution is laid over the brick-work steadily and carefully with a large flat brush so as not to form a froth or lather on the surface. This is allowed to remain for 24 hours to become dry. A solution made of a quarte, of a pound of alum in 4 gallons of water is then applied in a similar manner over the coating of soap. The operation should be performed in dry weather. The soap and alum, each acting upon the other, form an insoluble varnish which the rain cannot penetrate, and the cause of dampness is thus effectually removed.

Tar on Exterior of Brick Walls.—A coating of tar applied hot to the exterior of a brick wall will prevent the entrance of damp, but this remedy, though suitable for brick-work below the level of the ground and hidden from view, is unsightly when above ground. A small quantity of naphtha is sometimes added in the proportion of half a gallon of the naphtha to a gallon of tar; but the tar, plain and simple, will do quite as well. When the brick-work is below the ground-level, the earth must, of course, be removed, and the brick-work exposed to the air to allow it to dry a little before the tar, or any other coating that may be used, is applied. In such cases it is useful to dash fine sand against the tar, until the surface is thickly covered with it, and in a few days to apply another coating of tar, which should be sprinkled with sand as before. When the tar has hardened, the earth may be filled in.

Portland Cement.—Another plan for walls above the ground-level is to mix one part of Portland cement with two parts of fine sand, and add water enough to bring the ingredients to the consistency of thick cream. Cover the brick-work with a couple of coats of this mixture, and when it is quite dry, finish with a coat of paint.

Pointing Brick Walls.—When a brick wall has settled, and the mortar has hardened, the outer surface is usually finished by an operation technically called "pointing," which consists in raking out the joints between the courses and the bricks that compose each course, with the point of a trowel, and filling them up again with mortar specially prepared for the purpose.

In building there are two kinds of pointing, distinguished as *flat* pointing and *tuck* pointing, the latter being more ornamental than the former. As soon as the joints have been raked out, it is usual to colour the brick-work with a wash prepared for the

purpose, in order to produce a uniformity of appearance throughout the wall; but this, of course, need not be done when the bricks are good, and of the same colour throughout. A mortar is then made consisting of lime, fine river sand, in the proportion of one part of lime to two of sand, and enough ashes from a blacksmith's forge—which are used on account of their fineness—to impart a blue colour to the mortar. The joints are then filled with this, and if left in this way, the pointing is styled *flat* pointing. If, however, *tuck* pointing is desired a thin white line is laid over the blue mortar, in the centre of the blue line, so as to show a narrow blue line on either side of the white line. The effect of this is shown in Pl. P, Fig. 7. The mortar used for the white lines is what is technically called "putty," that is to say, plasterer's putty, and not glazier's putty, which is a different thing altogether. Plasterer's putty is fine white lime well slaked with water, and, indeed, having so much water added to it that the lime is fairly held in solution. The water is then allowed to evaporate until the pasty settlement that is left behind is of sufficient consistence for working. The mode by which an even edge and regularity of width is given to the white line is this. It is first laid over the blue mortar so as almost to cover it, and when it has nearly set, a straight-edge is applied, first to the top and then to the bottom of the white line, and the superfluous putty cut away with a knife or any thin and fairly sharp steel blade. When this has been done to all the joints, horizontal and vertical, the effect is produced of a white line on a blue ground.

The amateur artisan may occasionally require to point brick-work on his premises. It may be that he has built a shed against a brick wall, or in an angle formed by two walls, in which case one piece of walling will form the back and the other one side of the structure or he may have put up a small greenhouse in the same way, against either a part of one wall or portions of two. In either case, it is most likely that the old brick-work will want cleaning down and pointing.

The first thing to be done is to give the brick-work a good brushing with a birch-broom. This will have the effect of clearing away all the dirt and dust that is adhering to it. After this the joints must be raked out and a second brushing given to the wall. Finally, it should be washed clean with a hose or watering-can. The best kind of mortar for pointing work of this kind is Portland cement and fine sand in equal parts, mixed to the consistency of very thick paste. This composition must be

made up in small quantities at a time, so that it may not grow hard before it is used up. When mixed it must be placed on the mortar-board, which the amateur artisan will hold in his left hand, while he applies the mortar or cement with a small trowel held in the right hand. As he proceeds with the work, before each piece, or course, if done in single courses, has had time to harden, the surface should be worked over with a paint-brush dipped in water. This will impart a smooth surface to the cement, and fill up any little holes or depressions that there may be in the face of the brickwork.

Reduction of Surface of Brick-work.—If the old brick-work be very roughly laid, so that the ends and sides of some of the headers and stretchers extend beyond the proper plane of the wall's surface, it will be as well to reduce the prominent bricks to the ordinary level by chipping away the projecting parts with a cold chisel or a slater's hammer, which has one side shaped like a small hatchet, with a nick in it for breaking off projecting points of slate and a hammer-head on the other side. The reduction of all projections, which may be easily effected with one or the other of these tools, adds much to the appearance of the wall. After the wall has been pointed, and the face is dry, it may be lime-washed or coloured, according to taste or preference.

Roofing and Paving.—Although roofing is the peculiar province of the tiler and slater, and paving is usually executed by the paviour, yet the bricklayer is often called on to roof in a building with tiles, or to cover a floor with paving bricks, paving tiles, or even ordinary stock or place bricks. It will therefore be as well, instead of giving a separate chapter to a description of paving, to deal here with the method to be followed when bricks and tiles are used, and when laying stone paving. Covering in a roof with tiles may also be treated here.

Plain Tiles and Pantiles.—Let us begin with roofing, which may be done with plain tiles or pantiles, explaining that plain tiles are perfectly flat, while pantiles are curved in form something after the manner of the letter S. Tiles are hung by means of pegs to laths, called pantile laths, nailed on to the rafters of the house in a horizontal direction.

Roofing.—The great principle involved in roofing is that there shall always be two thicknesses of the material used, whether in tiles or slate, except in the case of pantiles, where it is unnecessary. The object of this is that the line of junction between

any two slates or tiles shall come half over the tile below and half under the tile above. By this arrangement any water that finds its way through the joint is stopped from entering the roof, and falls into the gutter below. All roofs of overlapping pieces of material of small size must of necessity be constructed on this principle, in order to be water-tight. The laths or strips of wood are nailed horizontally to the rafters, in order to afford a hold for the pegs or pins in the slates or tiles. A piece of boarding is usually nailed along the edge of the rafters just above the gutter in such a manner that the front of the tile that rests on it may be raised slightly above the back. Along this board a row of half-tiles is nailed, so arranged as to break joint with the tiles in the row immediately above. Holes are made on either side of the tiles in this row just above the middle, and pegs are thrust through these holes by which the tile is hung or hitched on to the pantile lath; the process is repeated until the top is reached, which is finished with a row of half-tiles or slates, and surmounted with a row of ridge tiles.

Repair of Slate Roofs.—It will be seen that all roofing made in this manner must be commenced at the bottom with the lowest course, and carried upwards until the ridge is reached. When the work is finished the pegs are not visible and it can easily be imagined from this and the general arrangement that when a tile or slate is broken it is no easy matter to remove it and insert a sound one in its place. It is often done by nailing a strip of thick zinc to the boarding or lath, pushing the slate or tile up under those that overlap it, and inserting its lower edge into the hook formed by turning up the lower end of the strip of zinc. If the old slate has been broken and any pieces remain, these and also the nails which held the slate in position must first be cleared out. For this purpose a tool known as a slate rip is used. The thin blade of the slate rip is pushed under the slates and the head of the nail caught in one of the notches formed in the end of the tool. Then by giving the "rip" a sharp pull downwards the nail is drawn out.

Another method is to clear away the broken slate and to fit a new one in the open space. In this case the joint below is filled in with fine hair mortar, and a thin bed of mortar laid on the slates. The new slate is then rubbed into position. To securely fix the slate, holes should be drilled through it just over the lath, filled in with white lead, and nails then driven through into the lath. The purpose of the white lead is to make the slate water-tight round the head of the nail.

Bricks used for Paving.—Stock and place bricks are often used for paving instead of paving bricks, or foot tiles; but being not so hard as these descriptions of bricks and tiles, they are more apt to break, and will wear away the quicker.

Paving.—In paving it is obvious that the first thing to be done is to prepare a firm and solid bed on which the material to be used may be laid and bedded; the second thing is to see that the bed is perfectly level, if a level flooring is required, or if it is desired to slope in any particular direction, or be rounded so as to throw off the water on either side, as in the case of a paved path, to see that the bed is sloped or rounded in the manner required. Paving is generally bedded in mortar, or cement, the latter being preferable if durability and solidity is required. All that is now necessary is to lay the bricks or tiles in regular order, spreading a little fine cement along the edges of adjacent bricks, and of each course, that they may adhere closely together, and that no gaps or chinks be left between them. If any brick or tile happens to be a little thinner than those next to it, a little additional bedding must be laid below it to raise it to the proper level.

Coloured Paving Tiles, etc.—Ornamental pavements for short walks from the roadway to the front door, or a square space before the front door and similar positions, may be laid in coloured paving tiles or encaustic tiles. The coloured Staffordshire paving tiles can be had square in various sizes, and in diamonds, hexagons, and octagons. Encaustic tiles can also be had in different combinations of colour, the price varying according to combination of colour and size. The method adopted in laying them is precisely the same as that followed in laying common bricks and tiles; but greater care, of course, is necessary in doing the work, in order to arrive at a satisfactory result. A true and solid bed must first be prepared, and on this the tiles must be laid with care, fitting them closely and accurately together.

If the natural foundation is not sufficiently sound, a bed of concrete should be prepared. This should be from 3 to 6 in. thick, and made of fine gravel and cement and well rammed down. To level the surface, float over about half an inch of cement and sand, leaving about a quarter of an inch more than the thickness of the tiles in order to have a good bed. The tiles are then laid in Portland cement. To cut the tiles, mark the face well in with a sharp chisel, gently tap at the back, and, if

the tiles are of good quality, they will readily separate. It is best to commence laying from the centre. In order to prevent any accidental displacement of the tiles, a layer of sawdust covered with boards should be laid across the tile pavement until it is properly set.

Fixing Coppers and Ranges.—Fixing coppers and ranges should be left to the professional bricklayer, as it is altogether beyond the ability of the amateur to accomplish such work in a satisfactory manner. It may happen, however, that cement or mortar may get loosened and fall away about a range or copper, and this the amateur can easily repair with a little cement and sand. He may even reset a copper if it gets loose, as it is nothing more than a circular vessel with a rounded bottom, and a flange about an inch in width at the top set in a casing of brick-work, so that the fire in the stove below may penetrate between the brick work and the sides of the copper.

The flange at the top of the copper rests on the brick-work, and the top is cemented over and sloped inwards so that any water that may escape from clothes when taken out of it may run back into the copper. Below the copper is the fire-grate, from which the ashes fall into the open space below, while the flame and heat ascend into the space between the brick-work and the sides of the copper. A circular wooden cover is generally kept over the copper, which in most cases, is built in an angle either in a corner of the kitchen or in one of the recesses by the kitchen or back kitchen fireplace.

Back of Register Stove.—It will have been noticed that the back of the register stove is sometimes made of fire-clay instead of iron. In course of time this part of the grate, of whatever material it may be made, will give way under the fierce and continuous heat to which it is subjected, and must be renewed. A new cast-iron back, or a fire tile of Welsh or Stourbridge fire-clay, may be procured from the ironmonger's.

Stourbridge fire-bricks, which are the best that are made, resist the action of fire. Welsh, and other descriptions of fire-bricks are cheaper. For the sake of security, if the amateur is building a small fireplace in a workshop or elsewhere, he is recommended to use fire-bricks instead of ordinary stock bricks.

Fire-clay: Where to get it.—It may happen, however, that the amateur may wish to mend any hole that has been burnt away at the back of his grate without having recourse to the

ironmonger or the smith. In this case he must procure some fire-clay from the builder's yard, or from the timber merchant, who generally keeps this material in stock.

Some little trouble is involved in the preparation of the clay, which must be softened and kneaded with water until it is sufficiently plastic for use. The cavity into which it is to be introduced must then be moistened with water and the clay pressed into it, especially if the bricks at the back have begun to wear away, as will sometimes happen. The front must then be finished off at the proper slope, which will be indicated by the sides or "cheeks" of the grate. The ability of fire-clay to bear a great heat without melting or vitrifying arises from the absence of any alkaline earth to act as a flux. The famous Stourbridge fire-clay contains about 64 per cent. of silica and 24 of alumina, the remaining twelve parts consisting of oxide of iron, water, and traces of carbonaceous matter.

CHAPTER IV

BUILDING WORK SUITABLE FOR AMATEURS.

Bricklaying, unless it be of the very simplest kind, involving no very great nicety in the operation, is a matter which the amateur artisan either will not care to undertake, or will often mismanage. Masonry, which will be noticed briefly in a future chapter, also presents difficulties which can be overcome only with experience. There are, however, methods of building which are more within the scope of the amateur, and these may be classified as: (1) *Building with wood.* (2) *Building with concrete.*

The method of building a shed in wood, and wood only, will be found at the end of this chapter; we will commence our remarks on this part of our subject with suggestions for, and instructions on, building with concrete, made by the amateur in the manner described in a previous chapter.

Working Drawings.—The first thing to be done when any kind of building work is about to be commenced, or any constructive operation whatever involving recourse to any of the building arts or trades, is to put the work accurately on paper; that is to say, to prepare working drawings in plan, elevation, and section, according to a certain scale. By doing this, the amateur will

be the better able to calculate what quantity of materials he will require; and by getting the plans that he has conceived in his mind definitely worked out on paper, he will be able to proceed all the more rapidly in the execution of the work from the commencement to the finish.

Simple Brick-work Building.—The only way in which any building operation can be clearly explained is to take a supposed case and to go through it in detail, and at present we will imagine that the amateur has a convenient corner in his garden, where two brick walls meet at right angles, one of which is high enough for the back of the building.

Assuming that the building is to be in brick, the mode of operation can be readily gathered from what has been said in the last chapter and what will be said here about concrete buildings. A caution, however, must be given that it will be useless to build up the new brick walls without tying or bonding them to those that are already standing. If the existing wall to which it is desired to attach another at right angles, has been built in Flemish bond, portions of the stretchers must be knocked out to admit of the insertion of stretchers at right angles to the depth of half the length of the brick, which will tie the new wall to the old one. It might at first appear easier to knock out the *apparent* half-bricks in the alternate courses but this is not practicable, as these bricks are headers, going right through the wall and appearing in either face both on the outside and on the inside.

To proceed in due order, we will suppose our building to be precisely 12 ft. long and 9 ft. wide, exclusive of the brick walls, against which it is to be built. The walls are to be 9 in. walls, and the opening for the doorway, which is to be at the end that we have to build, is to be 2 ft. 9 in. wide. The brick walls are also 9 in. walls. In making a working drawing for the work, the amateur will find it convenient to take from ½ in. to 1 in. to a foot for his scale. The opening for the doorway is 2 ft. 9 in. wide, and the walls are 9 in. thick.

Building in Monolithic Concrete.—We will consider, first of all, that it is intended to build the walls in "monolithic" concrete, that is to say, a wall composed of concrete built up piece-meal which hardens into a solid unbroken mass. The existing walls are, as already stated, of brick, but it is no less desirable that the new concrete walls should be bonded or tied to these, even though the materials are different, so we proceed in the first place to

knock out the stretchers or half-stretchers in order to form the tie Meanwhile trenches for the new walls have been excavated of the necessary width; that is to say, 9 in.—the trench need not be larger for concrete foundations—and the earth at the bottom of the trenches has been rendered solid by ramming the mould well together. The wall that forms the back of the building is 10 ft. high, and that of the side wall is only 6 ft., but we wish the front of the building to be 8 ft. high. This will give but little slope to the roof, but it is sufficient for the purpose, as the area of the roof will be but a little larger than the ground on which the building stands.

The construction of the window and of the roof will be explained later, but for the present we may consider only the walls or carcass of the structure. The amateur should remember that he is in no way bound to follow the dimensions here given; he will find that he must of necessity adapt his building to contingent circumstance; the dimensions here given are, for many reasons, very convenient.

The trenches having been opened, should be filled with concrete to the level of the ground and a stout door-sill of oak, about 3 in. thick, bedded on the concrete just on or above the ground level. First some scaffold-boards and stout stakes are procured, and the stakes are driven into the ground on each side of the space on which the wall is to be raised. Within these stakes, scaffold-boards placed on edge are arranged, the stakes being driven in at such a distance apart that the space between the scaffold-boards may be a little over 9 in., the required width of the wall, to allow for shrinkage. A short piece of board is put across the other board to form the end of the wall, or, as the wall at the side will be built at the same time, it will be better to set boards to form the doorway by placing stops across between the scaffold-boards which must be introduced when the wall has been raised to the height of 4 ft., and it is necessary to form the window opening.

The boards being set in place—say two boards on either side, which will give a height of 22 in.—and a quantity of concrete ready mixed, the concrete is thrown down with some force into the space between the boards in order to consolidate it, and allowed to settle well together. To save concrete and eke out the materials any rough stuff such as brick-bats, stones, flints, etc., may be placed in the middle of the wall, due care being taken that they do not come in contact with the boards on either side, and so appear in the surface of the wall. When the space between the

boards has been filled up, the mass must be left for two or three days to harden. It will then be found that the concrete has shrunk in settling, and does not come to the edge of the topmost board. The lower part of the wall being hard enough, the lower board may be withdrawn and placed on the top of the upper one, and the filling-in process repeated. On each occasion of adding new concrete, the upper surface, the block last laid, should be prepared by roughing it up with a pick, cleaning it off with a brush and damping it. The withdrawal of the lower board and the placing it above the upper board must be continued until the wall has been raised to the required height.

Special apparatus have been devised for building concrete walls of this kind, and for connecting them at right angles, either at the corners of a building, or where one wall is run out from the middle of another, but these are most expensive either to buy or to hire. All the amateur wants are the simple appliances already described. His stakes should be square and strong, and the opposite pairs should be connected with bolts or braces, so as to keep them equidistant during the construction of the wall; these, of course, can be removed when they interfere with the progress of the work. It is well, too, to fasten the stakes to the scaffold-boards by long screws, say of 5 in. or 6 in. in length, which can be withdrawn when the board must be removed. One of the chief objects in using the screws is to prevent any chance of the upper board slipping, when the board below it is withdrawn.

After the explanation of the process above given has been thoroughly mastered, the amateur will find no difficulty in building any concrete wall of moderate height in this way. It is necessary, however, now to turn our attention to the completion of the walls, first in front, and then on either side.

And first with regard to the front. When this has been raised to the height of 4 ft., a stout window-sill should be placed in position. This should be 6 ft. 6 in. long at the least, so as to extend 3 in. on either side beyond the frame of the window, and it should be 11 in. or 12 in. wide so as to be even with the inner face of the wall and project 2 in. or 3 in. beyond the outer faces. The wall should then be raised very nearly to its full height, when a wall-plate, at least 2 in. thick and 4 in. wide, should be laid from end to end of the wall, the outer part being even with the outer face of the wall. The window-sill below and the wall-plate above will thus form convenient parts to which to nail the frame in which the casement windows are

to be hung. When the wall is building it will be useful to introduce pieces of timber as long as the wall is thick, and about 3 in. square, to form additional points of attachment to which to nail the window-frame.

The end of the shed to the left hand, must be raised on the brick-work in the same manner as the other walls, care being taken to remove half-bricks, so that the side may be bonded completely to the wall. In building the end of the shed to the right hand, equal care must be taken to tie the end to the wall at the back. A strong lintel must be inserted, when the opening for the doorway is high enough, and, as with the window, bond timbers to which the frame may be nailed, should be inserted in the reveals of the doorway.

When all this has been done, it will be necessary to lay a wall-plate along the top and the back wall, and on the side walls as well. These wall-plates should be about 3 in. thick— certainly not less than 2 in.—and the side rafters should be cut so that the upper surface may be coincident with that of the inner edge of the wall-plate on the back wall, running away to nothing on the front wall-plate. All the wall-plates should be bedded in the concrete, and the spaces between the rafters when laid filled up with the same materials. Rafters about 2 in. thick and 3 in. deep may now be laid to form supports for the roof, one end resting on the wall-plate on the back wall, and the other end on the wall-plate on the front wall. On the top of each wall-plate must be laid a strip of wood to bring it level with the top of the other rafters; unless, indeed, and which would do quite as well, wall-plate and rafter at the end were combined in one piece, and halved on to the upper and lower wall-plates in such a manner as to bring them level with the rest of the rafters.

We are here more particularly concerned with the mode of building walls, but the method of covering in the roof will be given in detail in a later chapter. The making of the door and window, as well as the construction of the roof, belong strictly to carpentry and joinery. The mode of procedure in preparing and fixing the rafters has already been given; instructions for making doors and windows will be found in Chapter VIII of Part II of this work.

Pisé Wall or Wall of Rammed Earth.—If the amateur cannot get lime and gravel or stones for making concrete he may yet manage to make a wall very similar in character, namely, the pisé wall, or wall of hard-rammed earth, known in Devonshire

and Somersetshire as a "cob" wall. Moulds of board should be made and fixed in the same manner as for concrete walls, and suitable earth for the purpose having been obtained, this is used either by itself, or mixed with chopped straw, and, when put in the mould, rammed hard with a rammer, and left to harden. Houses made of these clay walls are durable, warm, and dry. The kind of earth or soil best adapted for pisé is that known as gravelly. By this term is meant a soil in which the pebbles are round, not flat or angular. Brick earths are well adapted for pisé, but owing to the capacity for retaining moisture, they are apt to crack, unless carefully shielded from the wet, during the process of drying the walls. All kinds of earth, however, may be used, with the exception of light, poor lands, and strong clays; these, however, will do if judiciously mixed with other better fitted soil. The principle of mixing is simply to blend a light earth with a strong, a clayey with a sandy or gravelly kind. All animal or vegetable substances that are apt soon to decay must be carefully kept out of the soil to be used. The following indications, which may be observed in order to judge of the fitness of the soil for pisé in any district, may be useful. In digging, if the spade brings up large lumps at a time, the soil is well adapted for the work; this holds also where the soil lies on arable land in large clods, and binds after a heavy shower and a hot sun. Where vermin holes are smooth in the inside and firm, or where the small lumps generally found in plenty in all fields are difficult to be crumbled between the fingers, the soil is good. Soil of good quality is generally found at the bottom of slopes that are in cultivation, and on the banks of rivers.

The foundations for an earth wall should be laid in brick, stone or concrete and carried from 1 ft. to 3 ft. above the surface of the ground. The construction of the mould is clearly shown in Pl. O, Fig. 7. In this illustration A represents the foundation wall in section, this wall being 1½ bricks thick, or 14 in. from face to face. In building this wall cross-pieces of timber, F G, must be laid on the top, when it has reached the height B C, and the spaces between these pieces filled in with walling until is is level with their upper surface. The top of the wall thus presents a continuous surface from end to end, broken only by the "joists," as these cross-pieces are technically called. The joists should be of hard timber, 4½ in. broad, and 2½ in. thick, that is to say, of the breadth and thickness of a brick. They should taper a little, that is to say, be about ½ in. less in breadth at one end than they are at the other, so that they may be easily knocked

out of the wall when it is necessary to remove them. Grooves about 1 in. wide, and the same in depth, should be cut *across* the joists at J and H, in order to receive the boards which form the "mould," and mortises must be made at K and L, as shown by the dotted lines, to receive the tenons cut at the ends K, L, of the posts K M, L N. These posts should be of the same dimensions as the joists, as regards breadth and thickness, and from 18 in. to 2 ft. in length. It is necessary to provide some contrivance for keeping the posts the same distance apart at the top as they are at the bottom, and this is done by means of cross-pieces, as shown at Q.

As the breadth of the wall is 14 in., and the thickness of the mould-boards shown at W, X, Y, Z, is 1 in., a cleat R, 16 in. long, must be nailed to the lower face of the cap Q, into which short pieces of the same breadth and thickness, shown at S and T, have been attached at right angles by means of the dovetail joints, O and P. Between these pieces and the heads M and N of the posts K M, L N, wedges U, V, are driven, in order to press these ends tightly against the ends of the cleat R. Frames of this kind, precisely similar to each other, must be placed at distances varying from 18 in. to 2 ft. along the wall, and within them the mould-boards are placed, between which the earth will be thrown and rammed. These mould-boards should be of good pine wood, not less than 1 in. in thickness; they should be dowelled or pegged together, and otherwise secured by battens screwed on to them at short intervals along their length transversely to the grain. From 6 ft. to 12 ft. will be found a convenient length for the mould-boards, and it is as well to have three or four pairs of mould-boards of different lengths.

To form the end of a pisé wall battens about 2 in. or 3 in. wide and 1 in. thick, must be nailed to the *inside* of the mould-boards, at one end, which must of course be the end where the wall is to terminate or be turned at an angle, and a piece of board fitted against the battens. When an angle has to be made, a special moulding may be made for the purpose, or the ordinary mould-boards may be arranged by means of battens. The frames and mould-boards being in position and properly levelled by means of the plumb-line and square, the earth should be filled in and rammed well together. Not more than 3 in. or 4 in. of earth should be put in at one time. The first strokes of the rammer should be made close to the edges of the mould and afterwards the whole surface should be rammed in regular succession, from the head of the mould downwards. Care should be taken to give

to each layer as equal a compactness as possible. The parts under the caps must be carefully looked to, as from their position the rammer must be used obliquely.

The mould being thus filled by successive layers, each equally well rammed, the wedges holding the caps must be withdrawn, the caps taken off, the sides thus released, and the joists finally drawn out of their holes in the wall, which should be filled up either with a mixture of two parts of cement, two parts of sand and one part of earth, or with wooden blocks which will be found convenient for fastening internal fixtures. The holes for the joists cut in the upper surfaces of the successive layers should be so placed as not to be exactly above one another in all the courses, but each succeeding series between those of the series below.

When a day's work is finished the wall should be covered with boarding, so that it may be protected in the event of rain, and the roof should be put on as soon after the walls are completed as possible. The roof should overhang at least 12 in., to protect the vertical walls from the effect of rain. The rammer may be made of hard wood or cast iron; if of the latter material its weight may be 14 lbs., or thereabouts. Bond timbers may be used with advantage in pisé walls; they should be of the length of the mould, and in breadth equal to one-third the thickness of the wall. As they are completely imbedded in the earth, they last for a great length of time. If considered necessary or more economical, the inside faces of the bond timbers may be made to lie flush with the inside wall of the house. In this case they will serve as battens in which to drive nails, for many convenient purposes. The openings for doors and windows should be left a little less than required. They may be dressed after the building is finished to the proper dimensions. Wood bricks should be built in here and there, to which to fasten the dressings and frames. The openings are made by placing heads, or a head, in the mould at the place where the wall is to terminate and the opening begin.

Wooden Shed.—In dealing with the method to be followed in building a shed in wood we will assume that the same plan and style of building is to be followed as in the structure described, and that the frame-work is to be in every way similar. It will only be necessary, therefore, to deal with the external covering of the frame-work with wood; there are two methods of doing this: one of these may be described as the *horizontal*

method, usually called "weather-boarding," and the other as the *vertical* method.

For weather-boarding, boards thinner at one edge than at the other, usually called feather-edged boards, are used. These are made by sawing a board in two pieces by a diagonal cut. To give a finish to weather-boarding a fillet should be nailed to the outer edge of the upright at either end of the space to be boarded over. This forms a rebate within which the ends of the boards are dropped and hidden from view. For weather-boarding the uprights should not be more than 18 in., or at the utmost 2 ft. apart, but then they need not be more than 2 in. square, or at most 2½ in. by 2½ in. unless the building is to have an upper story. If it is found convenient to place the uprights at a wider distance, diagonal braces should be introduced to strengthen the frame-work, and this may be done with good effect even when the uprights are close together.

If this system of strengthening by diagonal braces is desirable for weather-boarding or horizontal boarding, it is even more desirable for vertical boarding in which the boards are nailed to the frame-work perpendicularly edge to edge, or grooved and tongued, because the diagonal pieces afford means of nailing the boards to the frame-work at other points than at the top and bottom only. The boards are in this case simply placed edge to edge and nailed to the frame-work of quartering behind, battens or slips of wood about 2 in. wide and from ⅝ in. to 1 in. in thickness being nailed to the boards so as to hide the joints. This branch of building in wood need not be pursued any further, as from all that has been said the amateur will be able to finish a building in this style without instructions in detail. The method saves a great deal of trouble in tonguing and grooving, and when the boards shrink, as they will under the drying influence of the sun in summer, the batten will prevent any unsightly chink from showing itself. For roofs, and, indeed, for the front and sides of wooden buildings, this mode of covering the frame-work with vertical boarding is preferable to weather-boarding, for the water has a clear uninterrupted run from top to bottom in the direction of the grain of the wood.

In some cases it may be desirable to make the walls of a building of this kind as air-tight and impervious to damp as possible. To do this an *inner skin of horizontal boards* should be nailed to the frame-work and the vertical boards nailed over these. The *inside* of the frame-work should also be boarded over, and the space enclosed between the uprights and other parts of the frame-

work and the boarding nailed to them on either side, be filled with some non-conducting material. Ashes, or even sawdust, with shavings will do for the packing to be placed between the boards, but some difficulty will be found in filling the interstices completely with this material. A better way is to dispense with the inner skin of boards on the outside, and to cover the frame-work outside with Willesden paper, or one of the similar materials ordinarily used for roofing. A fuller account of such materials will be found in a subsequent chapter. (See p. 390.)

Referring once more to the battens with which it is usual to cover the joints of vertical boarding, a lighter and more elegant appearance will be given to the woodwork if the sharp edges of the batten on the outside are bevelled away, or, as it is technically called, "chamfered."

Box and Cap and Dash-board.—It is always desirable to finish a building of this kind at the bottom with a box and cap, or with a piece of wood attached to the face of the wall at an angle, and called a dash-board. Its chief purpose is to carry off the drip which would otherwise cause the bottom of the boards to rapidly decay, but it also prevents much of the splashing during heavy rain, which tends to make the bottom of a wooden building dirty, and therefore unsightly.

To form the box and cap, blocks of wood should be set at intervals of 12 in. or 18 in. along the bottom of the boarding to afford support to the box-board or front which is nailed to them. Above the blocks and box-board is nailed the cap bevelled from back to front so that no water may lodge on it, and fitting over the cap is a batten. The dash-board is put on in much the same way, and for this an inclination of about 45° will be found convenient. For a door, a dash-board may be attached without supports, or it may be made out of a solid piece sloped at the top, and "throated" or channelled on the under surface with a deep groove to prevent any possibility of water trickling from the dash-board under the door. In such a case the bottom of the dash-board would be at right angles to the face of the vertical boarding.

Gutters.—It is necessary to finish all buildings, of whatever kind with gutters so as to carry off the water when it rains and prevent a continual drip from the eaves. Brackets can be easily attached to the front of the building which has been described in this chapter, to carry a light zinc gutter, from which the water

must be allowed to escape into a drain or on to the ground below by means of a vertical pipe attached to the gutter. The method of making and fixing zinc gutters is described in a later chapter (p. 427). Wooden gutters or shutes may be very easily made, either V-shaped by nailing two boards together at right angles or rectangular by joining three boards so as to form a box-like trough. In either case melted pitch should be run down the seams to make them water-tight. In fixing the gutter, sufficient slope should be given to cause the water to flow in the direction of the outlet pipe. The gutter may be hidden from view and a more decorative appearance given to the front of the building by covering it with an ornamental fascia or crest-board.

Many other uses for these ornamental boards will suggest themselves. When, for example, a building has been made with a span-roof, sloping on both sides, a board of this description may be placed in a grooved cap over the ridge-board affording an appearance very much like that exhibited by ornamental ridge-tiles.

CHAPTER V

MASONRY AND THE WORK IT INVOLVES

Masonry that can be done by Amateurs.—If the amateur does but little to bricklaying, he will do still less with masonry, which involves the cutting of different kinds of stones in order to fix them into certain places. If a house or wall is to be built entirely of stone, then the mason is called into requisition instead of the bricklayer. His chief work, in addition to building with stones, is cutting and fixing stone lintels and sills to windows, lintels to doors, and all the stone-work that may be required in a house built of brick, such as keystones to arches, when cut in stone, sinks, doorsteps, and stone paving of all kinds. In addition to this he has to cut the slabs of which stone or marble mantelpieces are made, and fix them in their places.

Now it is evident that an amateur will do little, if anything, of this kind; he will rather leave such work to the regular artisan, for it is neither attractive nor pleasant.

All that will be necessary for the amateur to know with regard to masonry will be the different forms in which walls of stone are built, and the names assigned to the various styles; the terms technically applied to various kinds of mason's work; and the nature of some of the stone employed for walls, dressings, and

pavement. Beyond this, it will be certainly useful to know how a mantelpiece is put together, though he may never attempt to do it. His utmost efforts in masonry will, in all probability, be limited to fixing a garden step that has been dislodged from its position, or cementing a flag-stone that has been loosened. In fact, his work will chiefly be with cement, and in dealing with this, he may make blocks of artificial stone and paving-stone to serve his purpose, and the method to be followed in doing this will be fully described.

Building in Stone.—Let us first consider the different ways in which walls are built of stone, and the names that are applied to these various modes of building. In what is termed "random or rough rubble work," the pieces used are of all shapes and sizes, just as they come from the quarry; the stones are not squared or even dressed so as to be fitted together, but are put together as they may best suit. As in brick-work, a proper bond is obtained by laying the stones in such a manner that the line of division between any two stones comes over the middle, or as near the middle as may be, of the stone below, on which the ends of the contiguous and superincumbent stones jointly rest. The strength of the wall depends chiefly on the quality of the mortar. In every yard, a "through" stone, level and well bedded in mortar should be put across the wall. The spaces or interstices between the stones are filled in by what is called "grouting" or "flushing" i.e. thin lime which when poured into the spaces between the stones consolidates the whole mass. Excellent and strong walls can be obtained by this method. In "coursed rubble work," some attempt is made to preserve regularity as regards height in the stones that form any single course, stones similar in depth being selected for each individual course. The bond is obtained by the use of "stretchers" and "headers" alternately as in brickwork. The back of a coursed rubble wall is usually random or rough, the middle being filled in with grouting as in the case of rough rubble. Squared rubble, uncoursed, has the sides and faces of the stones squared, but is built random. In "ashlar" the stones are squared according to dimensions duly laid down, and put together very much after the manner of brick-work. In this kind of work, pointing is seldom, if ever, required, but in coursed work and rubble work, when the wall is set, the joints between the stones are raked out and finished with flat-pointing. In high class ashlar work, the

face of the stone is rubbed so as to present a perfectly smooth surface.

In "snail-creep" the stones are laid in various shapes and are frequently laid on a sharp point, the joints being made to run in every direction. Quoins in masonry are the stones at the corners of buildings. They are generally about 2 ft. in length, 1 ft. in height and 9 in. in thickness. In rough rubble walls they are usually left rough; in coursed and ashlar work they are chiselled.

Window and Door Jambs, Sills and Heads.—In common rubble work which is to be cemented, the windows should have chiselled stone sills. All sills should project 2½ in. from the face of the wall. Great care is required in setting window sills. The better plan is to fit them after the work is settled as otherwise the weight of the work at each end will often break the sill owing to the unequal settlement. The heads of doors and windows may be of rough stone or flat arches of brick. The jambs of doors and windows, if they are to be cemented over, may be brick.

Sawing and Dressing Stone.—Stone that will not cleave with any degree of certainty is cut into pieces of the necessary size and shape by means of a saw, generally worked backward and forward by two men sitting opposite one another, one on either side of the block that is being sawn. The face of building stone, and stone pavement, is usually dressed with a broad cold chisel, held in one hand and struck by a mallet round in form and sloping gradually from a broad top to a narrower bottom. Chisels of different widths are used by the mason in dressing stone for building purposes, and sometimes the axe, or mason's hammer is used in dressing stones for walls. The other tools are a trowel, about 7 in. long in the blade and 5 in. in the handle, the upper surface of the blade being about 1½ in. below the centre of the handle or the tang which enters the handle, and the A level, plumb-level, and spirit-level, and squares of wood and iron.

Reducing Surface of Stone.—The mode followed by the mason in bringing a stone, such as one intended for a hearthstone or the tread of a step, to a flat surface with a chisel is as follows. First, two chisel draughts are made at one side and the end of the stone something like what in joinery is termed a rebate. These rebates are made perfectly flat, and are tested by means of a straight-edge. Every part of the stone (in the rebates) should

coincide with the under side of straight-edge. A diagonal chisel-draught is then made, connecting the ends of the side and end draughts previously made. Another diagonal draught is made crossing the first diagonal, and meeting the angle of the end and side draughts. All these being made as near as possible of the same depth, on the spaces between the draughts being blocked out, a comparatively flat surface is obtained. This is brought as flat as required by the use of the square; or the level of the surface may be tested by using two straight-edges of equal depth, thus: place one along an edge or arris of the stone, and on the opposite one the other straight-edge; by looking over the upper edge of the one straight-edge, if the upper edge of the other coincides, the surface is level. The foregoing description may prove useful, in case the amateur should attempt to re-dress the surface of a stone from which some thin layers have been split in any part, and which makes a depression that disfigures the stone.

Various Kinds of Mason's Work.—Mason's work is differently described by the architect and builder, according to the form that it assumes. Thus it is "plain" when the rough surface of the stone is removed to produce a flat and level face. When any part of the stone is sunk below the surface as in a rebate or panel, the work is said to be "sunk." When work is rounded or hollowed out so as to form convex or concave surfaces it is said to be "circular." All cornices, heads of columns, etc., are said to be "moulded," and moulded work is distinguished as straight or circular, according as it runs along in a straight line like a cornice or is round in form like the capital or head of a column. When irregular cavities are sunk in the surface of any stone, the work is spoken of as being "rusticated" or "vermiculated."

Fixing Mason's Work.—In fixing all mason's work, it is first of all necessary that the pieces of which it is composed, whether it be for steps or a chimney-piece, a door or window-sill, or a lintel, be truly cut. The foundation on which it is to rest, if it be a door-step or a sink, must be properly prepared, so as to give a slight inclination to the stone, that the rain may run outwards from the door, or trickle to the corner of the sink in which the escape pipe is fixed. Almost as much skill is required in setting or fixing work as in cutting it. It often happens that a vast amount of labour is expended upon work by the cutter and the beauty of it quite destroyed through the incapacity or carelessness of the

setter. On the other hand, bad work is often made to look well through nothing but the skill of the cutter.

Construction of Chimney-piece.—Chimney-pieces are distinguished as flat or box, according as they consist of jambs and frieze, formed of single pieces, with a mantel-shelf above them, or in many pieces, so as to project boldly from the wall, and give the appearance of solidity. It will sometimes happen that a chimney-piece may, through damp or other means, be dislodged from its position. A little plaster of Paris or cement is often all that is required to put everything to rights again. In the construction of a chimney-piece of ordinary form two pieces of marble, polished on the face and one edge, are reared against the wall at the back—a longer piece on the outside, and a shorter piece on the inside—and these pieces are secured in their place by iron cramps set into holes cut to receive them, and set in place by cement or plaster of Paris, with which the lines of junction between the marble slabs and the wall in rear are liberally plastered. Against these slabs, at the very bottom, and resting partly on the hearthstone, is set a square piece which extends from face to face of the slabs, generally speaking, and is called a plinth. On the plinth is placed a necking rounded or cut like a moulding. Both plinth and necking are set to the slabs at the back by cement. On the necking is reared another slab less in width than the plinth by 1½ in. or 2 in.; which, when it is fixed in the place, has the effect of making a rebate of ¾ in. or 1 in. on either side. On top of this another necking is placed, and then all is ready to receive the frieze of the chimney-piece which rests on the short slabs on the inside of each jamb, and is secured in its place by cramps, and plaster of Paris as well. To hide the gap that is now left at the top of each jamb, and at each end of the frieze, a square block is placed on top of the necking. The shelf is last of all put in its place on top of jambs and frieze, and the chimney-piece is complete. Sometimes a projecting piece of carved marble, called a truss, is attached to the slab below the necking or in some cases the necking is dispensed with, and the slab carried up till it reaches the mantel-shelf, or very nearly so, leaving just room for a necking, below which projects a bold truss.

By following the preceding description, the amateur will find little difficulty in putting up a chimney-piece that has come away from the wall behind. He must remember, however, that plaster of Paris hardens very rapidly, and that no more must be mixed

at one time than is just sufficient to use with the piece to be fixed. Like cement, if kept on the premises, it should be stored in a perfectly dry place.

Fastening down loose Flagstones.—In dealing with a flagstone that has been loosened, the stone must first be taken up in order to see what has led to the loosening, which may have been caused by excavations made by rats, and many other causes. The substratum having been made good, and a bed of cement laid to receive the stone, the stone must be put in its place and worked about until it is exactly on a level with the stones around it. The joints may then be filled with cement.

Paving-stones, Substitutes for.—It has been said that the amateur himself may make excellent substitutes for paving-stones and building-stones—or, in other words, artificial stone for any purpose that he may require. This is simply another way of making and using concrete, and it will often be found very useful.

Let us imagine that in a paved way, consisting of a number of single stones of the same width laid end to end along the centre of a path, as is often the case, so as to afford means of access from one point to another without treading on the damp earth, a stone has by some mischance become cracked or worn away in the centre. If cracked, the pieces will soon become loose and dangerous, especially to children; and if worn into a depression in the middle, water will collect and stand there, if the path be exposed to the weather. The amateur desires to mend this without having recourse to the builder for a new stone, or to pay for putting the new stone in its place. The first thing to be done is to measure accurately the length and breadth of the stone to be replaced, and to make a shallow wooden mould of the same length and breadth *between the opposite and interior faces* of the sides of the mould. The boards used for the bottom of the mould should be planed smooth within, so that the face of the block formed within the mould may also be smooth. In filling the mould the first thing to be done is to provide for the face of the stone, which may be done by putting in a layer of cement of the thickness of ¼ in., and, on this, some cement and sand, the two layers forming the thickness of ½ in. The remaining space should be filled up with concrete of cement, sand, and gravel. The work should be done as quickly as possible that one layer may not get too dry before the next is put on. When the mould is filled, it must be put on one side, and left for two or three days to allow the contents to harden and dry out completely. When

this is effected, it will be found that the conglomerate of cement, sand, and gravel has shrunk, and that the stone will easily slip out of the mould. If the stone required be large, it is better to make the length and breadth of the mould a trifle more than the actual length and breadth required for the stone, to allow for the shrinkage of the cement. With patience and by the use of two or three moulds, the amateur may soon make stone enough to cover a considerable space. This will be useful for a long pathway; but for a greenhouse, workshop, or any similar building, it is better to make the floor all of one piece, with concrete thrown in, levelled and faced with cement.

Making or Repairing Step.—If a garden step or any other step with a treader of stone is required to be made, or if the treader of any such step has become dislodged, the first thing to be done in the one case is to make, and in the other to see to, the base on which the treader is laid, and which acts as the riser of a wooden stair in giving the necessary support and height to the treader. In this case, let us suppose that a step has to be made to afford access to a roadway that is elevated about 15 in. or 18 in. above the level of the garden within. The example will serve for any other kind of step or steps constructed in a similar manner.

The ground must be cleared out to the depth of two bricks' thickness below the surface, and on this, after it has been well rammed, brick-work or stone-work must be built up until the level on which the stone is to be placed is reached. Rough but sound bricks should be used for the outside of this work; for the inside, which does not meet the view, any bricks or brickbats will do.

The stone should be wide enough to admit of its extending 2 in. or 3 in. under the brick-work which serves as the riser for the next step and landing which is only its own thickness above the level of the roadway without. Supposing that ingress is effected through a doorway, the jambs of the door may be dowelled into the stone. No step that is properly made ought to become dislodged, but it frequently happens that through the carelessness or ignorance of the workman employed, the brick-work has not been brought sufficiently forward to afford a solid foundation for the step, and the back has not been let in under the brick-work but is merely butted against it. In this case, too, mortar will be used in all probability instead of cement, and the stone may have an inclination or slight slope inwards towards the brick-work instead of outwards. Water will then settle on the

stone, and soak down behind it, and when a severe frost sets in the stone will be loosened by the action of the frost. In such a case the only thing to be done is to extend the foundation, and with a cold chisel cut away a groove in the brick-work behind sufficiently deep to let the edge of the stone at least 1 in. under the brick-work above.

It will, of course, be readily understood that the amateur may, by the aid of a mould made of a few boards, form a foundation of concrete which will answer all the purpose of brick-work, and be less troublesome to make; or he may, if he like to do so, make blocks of concrete which he may build together instead of bricks. The projections of the stone treaders beyond the brick-work below them produce a pleasing effect; but if the amateur chooses to dispense with these, he can finish his work by facing the upper surface of the steps thus formed in concrete with cement.

It is unlikely, as it has been stated before, that the amateur will do anything in masonry beyond those things which have been described in this chapter. If he does, that which has been already said will afford suggestions for the contrivance and execution of more difficult work. It must, however, be remembered that it is sought to do no more in this book than to suggest work that is within the compass of the amateur and to explain the methods to be adopted in doing it. Indeed, the remarks that have just been made may be taken to apply to the general principle on which this book has been written, namely, that of putting the amateur artisan in the way of carrying out any piece of work according to the method that is usually followed in such cases as may be brought under his notice, leaving him to apply the information that is given, and the general instruction that he has gathered from it, to the special requirements of the particular piece of work that he may happen to have in hand.

CHAPTER VI

THE CONSTRUCTION OF ROOFS

THE ability to make a good, sound weather-tight roof will be of considerable service to the amateur builder, for it is by the soundness of the roof that all things that are under it are preserved from wet, and consequent injury. In this chapter it will be useful to consider the different kinds of roofs that the amateur may be called on to make for himself, the various materials with

which such roofs are covered in, and the manner in which these materials are used and put together.

Various kinds of Roofs.—With regard to the different kinds of roofs that an amateur may construct; these may be defined as the *lean-to* roof, the *span*-roof, and the *hipped*-roof. Of these, the lean-to roof is the most simple and therefore the most frequently made, while the hipped-roof is the most difficult of construction, and will only be resorted to when it is desired to put up a structure with gables, or of a more ornamental and diversified character than the simple rectangular buildings that are covered in with lean-to or span roofs.

The Lean-to Roof.—The lean-to roof, which is so called because it is composed of a single sloping piece extending from the wall in the rear of the building to the wall in front, has been sufficiently indicated, both in general character and construction, in Chapter IV. It will be enough to remind the reader that it is composed of parallel rafters, set to the same level throughout, supported and nailed at one end to the wall-plates on the wall behind, and at the other to the wall-plate on the wall in front. It depends entirely on the size and the material with which the roof is to be covered in, whether any cross-pieces of timber should be nailed on to and above the rafters at right angles to them. It sometimes happens that a lean-to roof is so large that it is necessary to support the rafters, then called *principal* rafters, on horizontal beams, extending from the wall at the back to the wall in front, uprights being mortised to the beams where they rest on the wall-plate let into the wall behind, in order to give support to the ends of the rafters that butt against the back wall. Larger rafters are then used, and these are placed at a greater distance from one another; to compensate for this, however, and to afford sufficient support for the roofing material, be it what it may, long horizontal pieces, called purlins, are let into the rafters, their number being determined by the width of the roof from back wall to front wall, and the rafters being slightly notched to receive them, and on these smaller rafters are laid at less intervals. These are termed *common* rafters, and are notched slightly on the under side to fit over the purlins. Along the ends of the beams a length of timber is nailed, against which one end of the principal rafter is butted, the topmost end being notched into the upright which is mortised into the beam and built into the wall. This upright is continued a little above the principal rafter, and affords support for the common rafter at the

topmost end, this rafter being notched at the other end over the timber fastened to the wall plate and supported in the middle on the purlin. Sometimes, if the length of the principal rafter is from 15 ft. to 20 ft., it is advisable to give additional support to the weight of the roof by putting in a strut, one end of which is mortised into the principal rafter, and the other butted against the lower end of the upright, which is properly sloped and mortised to receive a tenon which is cut at this end of the strut as well as at the other end where it is connected with the rafter.

It will be seldom, if ever, that the amateur will find occasion to construct a roof of this kind, the simple lean-to roof of single rafters being sufficient for his purpose. When a roof of this description is covered with boarding, if the boards are put on horizontally either as weather-boards or to be covered with asphalte-roofing or slates, the boards may be nailed at once to the rafters without any intervening timbers. If, however, the boards are put on vertically, two or three horizontal pieces after the manner of purlins should be nailed across the rafters to which the vertical boards may be nailed, or, to give additional substance and security to the roof, one set of boards may be laid on horizontally as a lining, planed up on the inside, and the vertical boards nailed down to these.

The lean-to roof is for the most part only used when the structure over which it is placed is built against or forms an offset from another building. When the structure itself is wholly detached from any other, having four sides of walls of its own at right angles to each other, or when the purpose to which it is to be put is such as to render a lean-to roof undesirable and a gable-end preferable, even though the structure be reared against another building, a span-roof should be made.

The Span-roof.—The span-roof consists of two rectangular pieces of roofing forming a certain angle with each other, and with the horizontal line from top to top of the opposite walls on which the lower members of the roof rest. The chief difference in point of structure between the lean-to roof and the span-roof is, that the rafters are placed in pairs instead of singly, and that they are butted against one another at the top, a ridge-board or ridge-pole intervening, instead of resting, as in the case of the lean-to roof, on the higher wall-plate on the wall to the rear. With regard to the slope of any roof, it must be remembered that the greater its inclination the more quickly will the rain that falls

on it run off. No roof need slope at any angle greater than 45°, and none should be less than 22° 30′. The latter slope is sufficient for all lean-to sheds; the former is usually adopted for greenhouses, where it is an object to allow the sun's rays to strike on the glass as directly as possible for the greater part of the time that the sun is above the horizon. An angle of 30° will be found a convenient and, at the same time, sufficient inclination for the roofs of most buildings that an amateur may put up; but in determining the slope or pitch of the roof it is manifest that he must, in most cases, be guided by circumstances of position and the purpose for which the building is intended.

If the material of which the span-roof is to be formed is heavy, then the beams or rafters should be pretty stiff, that is to say, they should not be less than 6 in. deep by 3 in. thick; but if the roofing stuff be light, rafters of less substance will do. The rafters are notched on to the wall-plates at their lower end, while the upper end of each is rested against the ridge-pole. In order to give stability to the structure, the rafters are connected by a tie, which renders the whole framework rigid. The same methods of adding purlins and common rafters if necessary, and of completing the roof, are used as in the lean-to roof, and if vertical boarding is to be used as roofing material it will be desirable to nail some horizontal pieces across the rafters from end to end, to which the boarding may, in its turn, be nailed.

Horizontal boarding may be nailed on to the rafters at once, and this may be covered with asphalte roofing-felt, or other waterproof material. The ridge may be covered with a cap, or piece of wood grooved below so as to fit over the ridge and rounded above. This may be made more ornamental by making another groove along the top of the rounded surface into which must be inserted a thin crest-board.

Roof-covering.—Having considered some of the forms which the roof may assume and the mode in which the necessary framework of wood is constructed in each case to afford a support for the covering material, we must now turn our attention to covering materials. The most important of these are boards, slates, tiles, asphalted felt and waterproof pasteboard, and sheets of zinc and corrugated iron.

The manner in which roofs may be covered with tiles, and also with weather boarding or with boards arranged vertically has already been described, and it will be unnecessary therefore to give further attention to these forms of roofing, the construction

of corrugated iron, lead and other metal-covered roofs requires some knowledge of metal-working and it will be better to leave the notice of them for that part of the book in which such work is brought briefly under the consideration of the amateur artisan.

In the present chapter we have therefore to consider only the methods adopted in covering roofs with slates, asphalted felt, and the patent waterproof pasteboard or canvas.

Roofing with Slates.—The methods adopted in covering roofs with slates and tiles are very nearly identical. The tile, as already explained, is hung by a peg, or two pegs, on a lath nailed horizontally to the rafters and called a pantile lath ; the slate may be hung on a lath in the same manner, or nailed on to horizontal boarding previously nailed down to the rafters to receive them. In all roofing operations, whether the material used be plain tiles, slates, pieces ot wood cut in the form of slates or tiles, and in ornamental figures, such as triangles, semicircles, etc., the chief points to be regarded are that in all places all over the roof there shall be a *double thickness* of the material used, and that bond shall be properly broken, that is to say, that the line of junction between any two slates or tiles shall meet on and over the centre of a solid slate or tile in the course immediately below, so that no water shall make its way through the roof and into the building below during a fall of rain, however long or continuous it may be.

Slating, Measurement of.—Slating is measured by the square, an allowance of 1 ft. being generally made for the eaves. An allowance of 6 in. is made on each side for cutting to hips and valleys, and when the slates are trimmed or cut at the bottom to present ornamental courses on a roof, at least one-third extra must be allowed.

Calculation of Number of Slates for Roof.—To find how many slates are wanted for a piece of roofing, multiply the length by the breadth, allowing for the row of slates below at the bottom and how much the rows of slates (or tiles) are laid one over the other. Of roofing slates, 120 are reckoned to the hundred.

Slates.—The most durable slates are those from the Welsh quarries. The under surface of the slate is called the *bed*, the upper or exposed surface is called the *back*, the top edge the *head*, and the bottom the *tail*, the part of each course of slates exposed to view when laid is called the *margin*, the *gauge* is the distance apart which the nails have to be inserted on battens or boards, the *lap* is the distance which the tail of the third course overlaps the

head of the first course; in practice the lap ranges from 2½ in. to 4 in., the average lap being 3 in.; the lower part of the slating hanging over a wall is called the *eaves*; the *verge* is the finished edge overhanging the gable wall.

Ordinary slating, if not done with wooden pegs, is put on with iron or zinc nails, but iron nails will rust, and the heads of zinc nails often fly off when struck with the hammer, zinc being a very brittle metal. Copper nails are better than either zinc or iron, being far more durable, but, at the same time, more expensive. Composition nails are a mixture of zinc, copper and tin. The alloy is much harder than either the copper or zinc; it does not oxidise to any extent, and the nails are better adapted for driving. They should be used for all important work.

Names and Sizes of Slates.—Slates are known in the building trade by different names, according to their sizes, as shown in the following table, which exhibits the size of each kind, the gauge that is most commonly used first, the number required for a square according to the gauge specified, and the weight per thousand (that is to say, 1,200) in the first and second qualities.

Name of Slate.	Size.	Gauge.	No required to Square.	Weight per Thousand (1,200). 1st Quality.	2nd Quality.
Doubles . . .	13 in. × 6 in	5 in.	480	15 cwt.	18 cwt.
Ladies . . .	16 „ × 8 „	6½ „	280	23 „	33 „
Viscountesses. .	18 „ × 10 „	7½ „	200	34 „	44½ „
Countesses . .	20 „ × 10 „	8½ „	175	38 „	50 „
Marchionesses .	22 „ × 12 „	9½ „	148	52 „	66 „
Duchesses . .	24 „ × 12 „	10½ „	114	60 „	77 „
Imperials . . .	30 „ × 24 „	13½ „	45	—	—
Queens and Rags.	36 „ × 29 „	16½ „	37	—	—

Preparing Roof for Slates.—The framing of the roof being ready, the first thing to be done is to nail the laths on which to hang the slates across the rafters, unless the framing has been boarded over to receive them, and to pierce and peg the slates ready for hanging. In order that the laths may be laid at a proper distance apart, it is necessary first of all to decide on the gauge, that is to say, the width, from the bottom of the slate to the line across the slate in which the holes for pegs are to be made, or through which the nails that pin the slates to the boards are to be driven.

Let us see, then, how to determine where this line shall be

drawn across the slate, and how to set out the roof for the laths. Suppose that the amateur is going to use Ladies, a slate which measures 16 in. in length by 8 in. in width. It is necessary for half the slate in the course above to lap over half two adjoining slates in the course below, to preserve all the requisites for a sound weather-tight roofing, and to allow of proper breaking of bond. He will remember that the width of a plain tile lath, or a lath used for slating, is 1½ in. and as half the length of his slate is 8 in. the width of his gauge must be 8 in. plus 1½ in., or 9½ in. To make the gauge, a piece of lath must be taken and two nails inserted in it 9½ in. apart. This being done, if one nail be drawn along the bottom of the slate, the other will trace the gauge line. To prepare the slates for hanging on the laths a tool is used, called a slater's sax or chopper and having a sharp point projecting from the back. The cutting part of the blade is used for dividing slates, and the point for piercing a single hole or two holes, about 1½ in. from each side. One or two nails are used according to the size of the slates, the nails being from 1½ in. to 2 in. long, and driven home so that there may be no projecting head, which would have the effect of lifting the slate that might lay next above it.

To set out the roof for the laths the operator must place his rule on the end rafters, so that the end may be 2 in. or 3 in. over the eaves, as may be required to give the necessary drip, and make a mark on the rafter 15½ in. from the end, and then 6½ in. below and 6½ in. above, continuing the marks upwards until the ridge of the roof is reached. This must be done, as it has been said, on each of the end rafters, and the marks must then be struck on the rafters intervening by means of a chalk line stretched across from end rafter to end rafter. Laths must then be nailed along the lines thus made, the top of the lath in every case being brought against the line; thus, in other words, the lath will be brought against the line, touching it, but will lie below it. In putting on the slates it will be found that the slates at each end of every other course will be of half width, and the first row of slates along the eaves will have to be cut off along the line of the gauge. The same method must be adopted for plain tiles.

All this must be done of necessity, but before the slates are put on there are other things that must be seen to as well. The rafters will, or ought to, hang over the wall, and to the ends of the rafters a facia should be nailed, to which the guttering may be attached. This facia-board should be made of substantial stuff, varying from 1 in. to 1½ in. in thickness, according to the

size of the building. The depth of the facia will depend upon the size of the rafters, but it will seldom, if ever, be less than 6 in. in width. Provision must also be made to give the first course of slates the proper inclination. If the first half course of slates were put on below the lath and in such a manner that the upper surface of the slate were parallel to the upper surface of the rafter, and the next course of whole slates were put upon it, it is plain that the upper part of the slate in question would be also parallel to the slope of the rafter, and that a space would intervene between the upper part of the rafter and the lower surface of the slate. This would have the effect of raising every course of slates further above the line of the rafters than that below it, and before many courses of slates had been put in position the nails would fail to catch and be sustained by the laths; or, supposing that the upper end of the slate were pressed down so that the nail might catch on the lath, the lower portion would be raised above the surface of the slate below it. In a roof covered in this way there would be neither stability nor capability of resistance to the weather. It is necessary, therefore, to seek means by which the inconvenience and error already described may be avoided, and a proper inclination given to the first course of slates or tiles.

To do this effectually and in a proper manner a piece of wood must be nailed to the rafters, of such a shape as to throw the outer edge or bottom of the slate or tile upwards; or, what is all the same, the rafters must be blocked at the ends with pieces having a wedge-like form and a strip of board nailed on these from end rafter to end rafter to carry the first half course of slates. The first half course will then take the proper position, and the first whole course, hooked on with pegs to the lath, will lay flat on the half course. Every course of slate in a slate roof, and every course of tile in a tile roof, rests on the slate or tile, as the case may be, immediately below it. The facia should be raised sufficiently high to cover the ends of the rafters and the ends of the pieces nailed on them.

We will pass on now to the last kind of material that will require mention here, and this includes the asphalte felt and the Willesden roofing pasteboard.

Asphalte Felt.—Asphalte-felt or roofing-felt is a strong, coarse material made of hair, and apparently all kinds of hair-like refuse that will mat together under pressure, rendered waterproof by being saturated with tar. It is dirty to handle, and

not very easy to cut, but when nailed over boarding and tarred and sanded it affords a durable roof impervious to weather. All roofing-felt of this kind requires dressing with tar and sand once a year to preserve it. When left exposed to the sun and rain for some time without dressing, the tar with which it is saturated loses its power, and the felt gets broken up. This kind of roofing material is sold by most ironmongers and oilmen. Before the boards are covered with the felt they are coated with a mixture composed of 5 lb. of whiting and 1 lb. of tar boiled together and laid on while still warm. The felt is then laid over the boarding of the roof in horizontal slips from side to side of the roof, and secured in its position by flat-headed nails; the lowest strip must be laid first, and then the one immediately above it, which must lap over the lowest slip to the extent of 2 in. or 3 in. Zinc or copper nails are better for nailing felt to wood than iron nails.

Willesden Paper.—A better material, however, than the foregoing, more cleanly and comfortable to handle, and more easily cut, exists in the patent Willesden paper and canvas, which are now very generally used.

The Willesden 4-ply roofing used for sheds, farm buildings etc., may be obtained in rolls of any length, 19 in. and 60 in. in width. The rafters must be spaced 1 ft. 5 in. from centre to centre for the 19 in. width, and 1 ft. 7 in. for the 60 in. The 19 in. width is the more convenient for roofing. No boards are required as the material is battered directly upon the rafters. Its durability is proved by the fact that structures covered with this roofing have been standing exposed to all weathers for many years without injury. One of its chief merits is its lightness, as the substructure necessary to support a roof composed of Willesden paper need not be in any way so substantially made as one intended to support a roof of tiles, slate, or iron. Compared with galvanised iron for weight and capacity, 100 square feet of Willesden paper weighs 16½ lb., and the same area of galvanized iron, B.W.G. 24, weighs 145 lb.; and 1 ton of the former covers 13,500 square feet, and 1 ton of the latter 1,540 square feet. In fixing this roofing due regard must be given in the correct spacing of rafters and studding for the reception of the 4-ply Willesden paper without boards. There must be a distance of 17 in. from centre to centre of rafter or stud for 19-in. roofing—which must be used for all buildings over 12 ft. span—and 19 in. centre for 60-in. roofing. Good and cheap rafters may be obtained

by sawing two flat cuts in 7-in. by 3-in. battens, which will give 3 pieces each 3 in. by 2¼ in. Being made in rolls, 19 in. and 60 in. wide, these distances should be strictly observed, so that the edge of one sheet laid vertically from eaves to ridge will overlap the edge of the adjoining sheet 2 in. at every joint, and there be fixed with outside battens on every rafter and stud.

The 4-ply roofing is turned round the ridge and then run down the rafters to the eaves, and there turned round a feather-edged board. With the spacing described above, it will be seen that at every joint there is a 2 in. overlap, and that overlap covers a rafter. The roofing is held securely by outside battens 2 by ¾ in., which must be firmly nailed down through the overlapping roofing into the rafter. The nails used should not be less than 2½ in. to 3 in. long. A few tacks can be used to keep the roofing in place until the battens are put on. The battens should be painted three coats for permanent work before fixing, and should be free from large knots and sap. Care should be taken that they are nailed through both the overlapping sheets, so that neither can blow nor pull out. The fixing at the ridge is completed with the ridge roll; that at the eaves with a facia-board; or a batten can be nailed along the under side of the eaves-board holding the roofing to this. The roofing should not be run right over a roof from eaves to eaves. The fixing to the side studding is on the same principle, outside battens being used to hold the roofing to every stud. Each sheet of roofing should be cut long enough to extend from eaves to ridge, allowing sufficient length not only to permit an overlap at the ridge, but also for turning under eaves-boards. To render the roofing more pliable where a sharp bend is required, as at ridge or eaves, both ends of the sheet—say 6 in. up—may be placed in water 15 or 20 minutes, but *in no case* should the *entire* sheet be plunged in; or the part to be bent may be damped both sides with wet flannel (hot, if time is an important consideration). In case of accidental damage, the fracture may be repaired by simply sticking a piece of 1-ply paper each side with white lead and best gold size. For permanent work it is best to paint the paper every year.

The fixing of the 2-ply paper is managed in the same way, due attention being paid to the spacing between rafters or studs. Boards are first laid closely together on the rafters, and the paper is then laid from the ridge to the eaves, much in the same manner described for the 4-ply, except that beneath the paper, at every

joint, a thin strip of wood, 3 in. by ½ in., is inserted to throw the water off by slightly raising the surface, thus obviating any chance of a leak. The external battens are then put on, and the roof finished in the same manner.

CHAPTER VII

PLASTERING AND ITS VARIOUS BRANCHES

THE plasterer's work lies both within and without the house, but it is in the interior that his services are chiefly called into requisition. When the walls are complete as far as the bricklayer or stonemason is concerned, they are as rough inside as without, and the plasterer's business is to give the inner surface of the walls successive coatings of plaster in order to render them smooth, for the reception of paint in oil or distemper, or wall paper. He has also to make good the party walls within the house which divide one room from another, whether they be of brick nogging, or simple partitions of lath and plaster. He coats the ceilings with plaster, makes, or rather moulds, the cornices, and finally whitens the ceilings and colours such walls as are to be coloured with a wash stained to the desired tint by the addition of a little colouring matter to limewash.

Outside the house the duties of the plasterer lie in coating brick-work or stone-work with stucco, prepared with cement, which hardens into a solid sheet impervious to rain, and in covering external walls with rough cast. It may be as well to consider plasterer's work, first as relating to the inside of the house, in coating the walls and ceiling of a room with plaster, and putting up a cornice and any other enrichments that may be deemed necessary; secondly, with regard to external work, such as covering the outer surface of walls with stucco or rough casting; thirdly, with reference to repairs both within and without the house; and, lastly, respecting the mode of whitening ceilings and colouring walls, and the method of preparing white and coloured washes.

Materials and Tools used by Plasterer.—Before entering into detail on these points it may be useful to consider the materials and tools used by the plasterer, and the extent to which a certain quantity of various kinds of materials used will go.

The material used by plasterers is classified as "coarse stuff," "fine stuff," and "gauged stuff." These differ one from another

in the materials used, their relative proportions, and the manner of preparing them.

The usual process of plastering consists of "rendering" with coarse stuff, "floating" with fine stuff, and "setting" with gauged stuff.

Coarse Stuff is common lime mortar, with a small quantity of hair mixed with it in order to spread through it and bind it well together. The proportions in which the lime, sand, and hair may be mixed to form coarse stuff are lime-paste, 6 parts; sand, 12 parts; hair, 1 part. The hair used is procured from the tan yard, where it has been scraped from the hides. It is beaten out with laths or laid in water a day or two before it is mixed with the lime so as to separate the hairs.

Fine stuff is lime paste thinned with a moderate quantity of water to the consistency of cream. It is then allowed to settle, the surface water is poured off and the remainder is left to stand until it has hardened sufficiently for working. A little sand is afterwards added to it, and thus tempered it is used as a finishing coat over the first coating of coarse stuff.

Gauged stuff is formed by adding 1 part of plaster of Paris to 3 or 4 parts of fine stuff. For finishing off repairs this preparation may be used with considerable advantage, but the amateur must remember that the addition of the plaster of Paris will cause the mixture to *set* or harden very rapidly, and that no more must be mixed at a time than the operator is able to use conveniently. The actual proportion of plaster to be used will depend on the nature of the work, the time available for setting, and the state of the weather, more being required when the atmosphere is damp than when it is dry. It should be remembered however that an excess of plaster will cause the coating to crack.

With regard to quantities of material used in plastering, it is estimated that 1 cubic yard of lime (chalk), 2 yards of road drift or stand, and 3 bushels of hair will cover 75 yards of *render and set* on brick, or 70 yards on lath. The same quantity will cover 65 yards *plaster or render*, two coats and set, on brick, or 60 yards on lath. Floated work will require about the same as two coats and set.

The thickness of the coating with which a wall is covered will of course influence the quantity of cement used in the operation. One bushel of cement will cover 2½ superficial yards half an inch thick. From this it will be easy to calculate the quantity of cement required when the area to be covered and the thickness of the required coat are known. It must be

remembered that the cement is weakened by the addition of sand, and that if a strong and durable coating of stucco is required, it will be better to use equal proportions of sand and cement. A useful and sufficient thickness will be found in ¾ in.

A *hod* of plaster is reckoned to be about ½ bushel; 2 bushels of grey lime or 3 of blue lias are equal to 1 bag; 20 bushels of sand go to 1 yard; 3 bushels of cement make 1 sack; and a cask of Portland cement contains 4 bushels; 14 pounds of plaster of Paris constitutes 1 bag, and 7 bags make 1 bushel.

In addition to the above memoranda, which may prove useful in calculating quantities required and in buying, it may be desirable to remind the reader that a bundle of laths contains from 360 to 500 feet run, whatever may be the length of the laths. It is reckoned that 1 bundle of laths and 500 nails will cover about 4½ superficial yards. The single fir laths are from ⅛ to ¼ in. thick, and often less than this; the stouter or double laths are about from ¼ in. to ⅜ in. thick.

The Plasterer's Tools.—The tools required by the plasterer are hammers, trowels, floats, moulds, and brushes. Other tools are used by the regular plasterer, but these will be all that the amateur-artisan will want, as it is unlikely that he will try his hand at anything other than mere repairs. The hammer used by the plasterer has a face on one side for striking nails, and an axe-shaped blade on the other, with a nick in it on the bottom of the blade. This blade is used for chopping and breaking laths to the proper length when necessary. The nails used for attaching laths to quartering of partitions, or joists of ceilings, are furnished with a head, and resemble, in some degree, small clasp-nails. For putting on coarse stuff the ordinary bricklayer's trowel may be used: but for laying on fine stuff, and smoothing the finishing surface of a wall, a laying trowel of peculiar form and make, with the handle springing from and parallel to the blade, is required. Plaster can be spread far more easily and smoothly with a trowel of this construction than with an ordinary trowel.

The kind of mortar-board used by the plasterer for holding his plaster is technically known as a "hawk." It is made of hard wood about 14 in. square, and is somewhat thicker in the middle than at the edges. The round wooden handle is about 6 in. long. The "darby" is a piece of board 4 ft. long by 4 in. wide, used for levelling large surfaces. It is provided with a handle like that on the "hawk" near one end. The float is a wooden tool similar in shape to the darby, which is dipped

in water and worked over the plastering to produce a smooth and even surface. It is about 12 in. long by 4 in. wide and is usually fitted with a loop handle. A long straight edge, called by plasterers a "screeding rule," is also used for testing and levelling the surface of the work. The "scratcher" which is used for roughening or scratching the surface of the first coating before the second is laid on, consists of a few short strips of wood pointed at the end and held in position by cross pieces so as to form a kind of prong.

The brush chiefly used by the plasterer, whether for applying water to the surface of his work or for washing the dirt off walls that are to be re-coloured, or ceilings that are to be whitened anew, is from 4 in. to 6 in. in width across the broad part of the handle, to which three tufts of long hair are fastened, the whole spreading out into a broad, flat brush capable of holding a good deal of water or colouring matter, and of being worked over the surface of plaster without doing more than remove the external coating of dirt and colouring matter when the wall or ceiling is being cleaned.

Lathing.—Proceeding to consider plasterer's work in the order set out in a previous section, there must, of necessity, be some surface to which to apply the plaster. This exists, of course, in all brick and stone walls and brick nogging partitions in the rough surface that brick-work or stone-work presents, and to which plaster will readily cling; but in ceilings and ordinary partitions of framed timbers or quartering, an artificial surface must be created on which the plaster may be laid. This is effected by means of laths, which are nailed to the exposed timbers. It is unnecessary here to enter on the various modes of making a ceiling, or rather framing together the timbers of which it consists, as that is a process which belongs strictly to carpentry, and has been dealt with elsewhere.

Whether it be for the formation of a ceiling or a partition, laths must be nailed all over the timbers at distances which will vary from $\frac{1}{4}$ in. to $\frac{3}{8}$ in., according to the nature of the work. In common lathing the spaces should be $\frac{1}{4}$ in.; when the coating is very thin they may be a trifle wider. The interstices between the laths render the surface far better for coating over with plaster than a smooth surface. When the mortar is put over the laths part of it penetrates between them, and when hard, keys the plaster to the laths, and is difficult of removal. A lath and plaster partition between two rooms, or between a room and a passage

without it, must be covered with laths, and plastered on both sides. As the first coat of plaster is spread it is scored over by means of the trowel or the scratcher with rough diagonal lines about ½ in. deep, and these rough and deep lines, which are made at a distance of about 2 in. apart, serve to hold the second coat of plaster to the first in the same manner as the interstices between the laths gave material assistance in holding the first coat.

Great care must be taken in reducing with the float the finishing coats, whether there be two or three, to a surface smooth and level in every part, as there are few things more unsatisfactory to the eye than an uneven wall, receding in some parts from, and projecting in others beyond, the true surface. Equal care, too, must be taken in finishing the arrises or edges of projecting chimney-breasts, or of any recess in the wall where the two surfaces of the wall and the reveal meet at right angles. These salient angles and the converse of them, i.e., the re-entering angles formed by the meeting of two sides of a room, or the reveal of a recess and the wall at the back, must be finished in the same careful manner, otherwise the room will not look well when it is papered, Sometimes, to assist the plasterer in covering his walls with plaster, a strip of wood is nailed to the chimney-breast on either side, and occasionally in the angles of the rooms, and the plasterer governs his work by these strips.

In plastering it is desirable that the work, from the first coat to the last, should harden as soon as possible; in the first place so that the plasterer may proceed from one coat to another with little delay; and, secondly, that the plaster may be covered with paint or otherwise treated as soon as it is in a fit state to receive it. For this end various cements have been introduced in which some foreign ingredient is mingled with the usual materials, with the view of making the plaster set slowly enough to be manipulated with ease, and render it fit to be painted on at once as soon as it is set. For all practical purposes there is nothing better than Portland cement, but the cements known as Parian cement and Martin's cement have long been popular, the latter being said to have the advantage from its chemical composition of covering more surface in proportion to its bulk than any other similar material.

Most of these internal cements attain a very great degree of hardness, and they are capable of receiving a polish almost equal to marble; they are rubbed down with "grit-stones" of various qualities, a stopping being added—that is, plaster in a semi-fluid state—which fills up the pores; this is followed by the

same process with "snake stone," and finally finished with putty powder. The chief advantage of Parian cement is that, from the character of the material with which its base—plaster—is qualified, it will take paint almost immediately; indeed, the sooner it is painted the better. In workmen's phrase, the brush should follow the trowel, and this enables rooms to be finished ready for occupation at once, instead of having to wait a whole season for the plastering to dry. In additions and alterations, where expense is not of the first importance, this renders its use of great advantage. Martin's cement, when used for internal work, can be painted upon in a few hours, a desideratum where rapidity of progress is absolutely necessary. It is to be mixed with clean water, and, when it has been well beaten up, it must be applied to walls like plaster or cement of an ordinary kind.

Repairing a Plastered Ceiling or Wall.—In patching a plastered ceiling, it is necessary in the first place to see that all loose plastering is removed and that the patch is given a more or less even outline, sharp angles being avoided as far as possible. The lathing should then receive attention, and if it is weak or broken it should be secured or replaced with new work. When dealing with small patches it is usual to bring the work forward sufficiently to receive the setting coat at one application, but if time allows, it is advisable to give three coatings as in new plaster-work. Before applying the coarse stuff, the edges of the older work should be wetted. The common practise of splashing water from a brush over the laths as well as the plaster is not to be recommended as the laths when wetted to excess are liable to warp and twist. The setting coat should be of lime paste, gauged with fine plaster, and a little size. After being levelled flush with the old work it should be trowelled off. It should not be scoured, as this process "kills" the plaster, and therefore weakens the material. For small patches, Keene's or Parian cement may be used, these materials having the advantage of setting quickly, so that the work can be completed at one operation instead of waiting for one coat to dry before another can be applied, as when ordinary lime plaster is used.

Cornices, Mouldings, etc.—If a cornice is to be added round the top of the room, and a rose to be affixed to the centre of the ceiling, this work should be done before any attempt is made to whiten the ceiling, or to colour, paint, or paper the walls of the room.

With regard to the cornice, if this is very large, and conse-

quently too heavy to be made solid, it is usually cast in pieces and fixed in position. Otherwise a foundation may be made by fixing blocks of wood, either triangular in form or approaching even more nearly to the outline of the cornice, and to these laths or slips of wood may be nailed, on which the first coat of coarse work must be spread. The brackets which form the primary foundation of the cornice may be a simple triangle or cut into projecting angles and recesses; but, however this may be, the mode of procedure as regards the rest of the cornice is the same in either case; for laths are nailed to the faces of the brackets, and on the rough surface thus formed the plaster is spread. Cornices are generally formed in fine stuff or gauged stuff so that they may set quickly, and a regular shape is given to them from end to end by means of a mould or template, which is cut out in wood and run along the surface of the plaster to bring it into the required form. Of course this need only be resorted to in the case of broad or massive cornices which are not cast before fixing in position. When the cornice is but small, and therefore of no great weight, the plaster may be run along the angle formed by the meeting of the planes of the ceiling and the walls of the room and moulded without the help of any foundation. If possible, as little width as can be conveniently arranged should be allowed at the top of projections because the dust will settle on any such projecting piece and form a dark line, which will detract from the general effect of the cornice. Cornices should be coloured in distemper with the prevailing tints in the wallpaper. Unless the amateur is possessed of some skill as a modeller he is advised not to attempt a cornice in cast work.

Ceiling Flowers.—A rose in the centre of any ceiling is a great addition to the general appearance of a room. These were originally made in plaster, but may now be procured in papier mâché, with a priming of whiting and glue over it. They can be easily fixed to the timbers of the ceiling with screws. When a gas pendant or chandelier is fixed to the ceiling, the centre of the ceiling flower is cut out to receive the wood block of the gas-fitting.

Plastering Outer Walls.—The covering of the outer surface of walls is generally done by the application of rough-cast or a coating of stucco. The object is partly to obtain a surface impenetrable to moisture, and partly for the sake of giving a better appearance to the walls. In the case of walls of concrete built on the monolithic system an outer facing of stucco is

required to fill up the crevices, and so conceal all blemishes and imperfections which are inseparable from this mode of building.

Rough-cast Coating for Walls.—Rough-cast is made by putting some mortar in a shallow tub, with sufficient water to bring it to the consistency of cream; a little fresh lime is then added to it, and some very fine and small shingle mixed with it. Another mode is to wash gravel or coarse sand until all the finer particles are carried away, and then mix the residue with fresh slaked lime and water until the mixture is of the consistency of cream. Rough-cast, however, looks better with the addition of a little shingle.

Stucco.—A concrete wall should be covered with stucco rather than rough-cast, but if it be decided to rough-cast a wall of this description, all holes of any size should be stopped with cement or plaster before the operation is commenced.

When all is ready, the workman damps the surface of the wall by dipping his large brush in a pail of water and sprinkling the water over the wall. This done, he takes up the rough-cast either with his brush, on a trowel, or in his hand, and throws it against the surface of the wall, to which it will adhere. Sometimes, in the case of brick or stone walls which are coated with rough-cast, a coating of lime mixed with hair—plaster, in fact—is first laid on and before this is set the rough-cast is thrown against it. Occasionally small pebbles or coarse sand are thrown against the plaster, and when dry the surface is coloured with a wash of lime and sand. A good effect can be produced in rough-casting by dividing the surface of the wall into panels by means of thin strips of wood or iron rods, which must be fixed by nails. The framing of the panels can then be filled with cement, which should be brought to a smooth surface and painted and the panels themselves filled with rough-cast.

Stucco for exterior work is made of cement or lime in the proportion of one part to two or three parts of clean sharp sand. The wall to be stuccoed should first be prepared by clearing off all loose dirt, mortar, etc., with a stiff broom. Then apply the mortar in two coats: the first a rough coat to cover the inequalities of the wall, the second as a finishing coat. The latter, however, should be put on before the former is dry, and as soon, indeed, as the first coat is sufficiently firm to receive it. The whole should then be well floated, trowelled, and marked off, and if it is to be coloured in water colour the wash should be applied so as to set with the stucco. Walls should be thoroughly dry before stucco

is applied to them. Spots of damp will cause the plaster that covers them to rise and swell, and ultimately to crack and fall off. Cement stucco will take paint well, though a brush is soon worn down and worn out when worked over so rough a surface.

The amateur will probably not at any time attempt to stucco the side of a house, however great an improvement would be affected thereby, but if he has built a greenhouse against an old brick wall, the brickwork that appears in the interior of the structure will be all the better, and certainly more pleasing to the eye, if it be hidden beneath a coating of stucco. Again, it may be desirable to execute repairs either within or without the house, without sending for a plasterer or bricklayer; and it is in these minor points that a knowledge of how to make stucco and plaster, and how to apply these compositions, will be useful.

Repairing Stucco Work.—It may be supposed, for example, that, by some accident, a large piece of stucco has been knocked off the outside of the house, or that the sharp clean edges of a stuccoed corner have been carried away by a garden roller accidentally brought in contact with it.

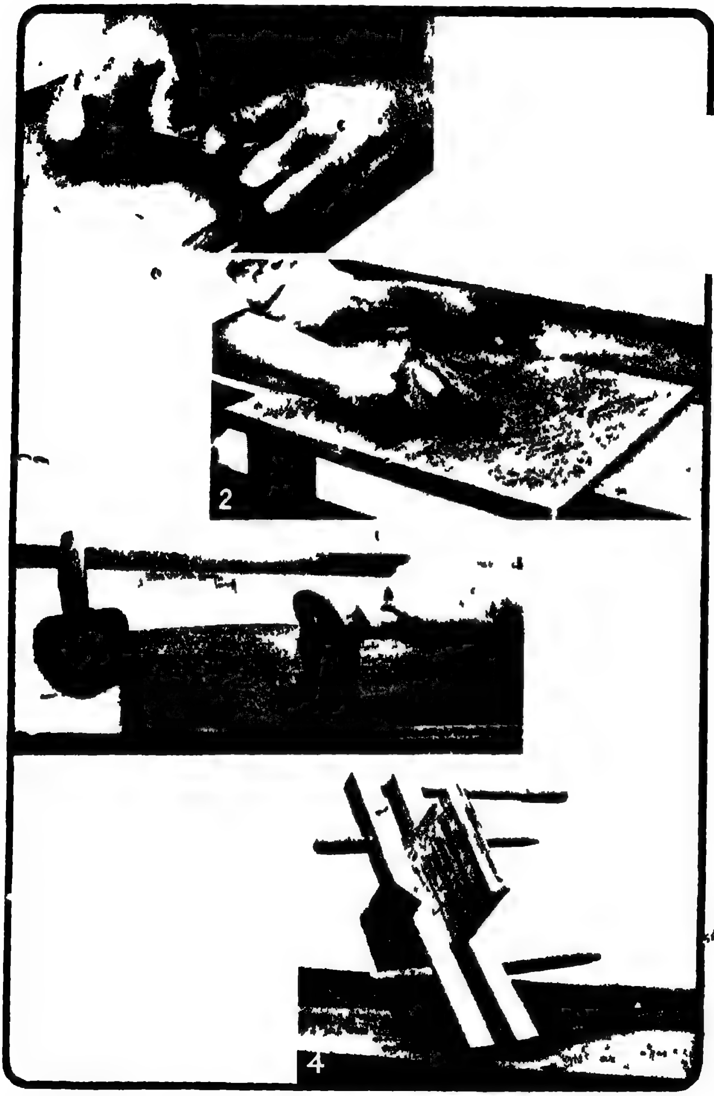
As explained in connexion with the repair of a ceiling, all the loose stuff must be carefully cut away, until every atom of it has been removed and the surrounding parts are perfectly solid. The edges of the firm part must then be sprinkled with water, and the new plaster or stucco put on as directed above. Where the damage is but slight the dust should be carefully brushed away out of the hole, and the cavity slightly wetted and filled up with a little cement or plaster of Paris.

Whitewashing and Distempering.—Walls and ceilings fresh from the hands of the plasterer require no preparation prior to whitewashing; but when either wall or ceiling has got dirty through dust and smoke, all the dirt must be washed off before any attempt is made to whiten or colour its surface. It will be as well to begin with a description of the washing process. The operator should stand on a strong table, or on scaffold-boards supported on trestles, so as to be within easy reach of the ceiling. Dipping his large brush in a pail of clean water, he should then draw it slowly backwards and forwards over the surface, pressing the hairs of the brush firmly against it, raising the brush frequently, and changing the water as often as it gets discoloured by the dirt that comes away from wall or ceiling on the brush. Continue the washing until scarcely any soil is communicated to the water by the brush. When the dirt is

Plate XXV—FRETWORK

(1) Sawing board (2) Fret cutting with hand saw

Plate XXVI- VENEERING



(1) Use of cabinetmaker's scraper (2) French polishing (3) Laying a veneer with hammer (4) Use of handscrews

completely removed, let all roughnesses be scraped down, and cracks carefully stopped with plasterer's putty. The best liquid coating that can be used, to whiten or re-colour the walls and ceiling is undoubtedly limewash—that is to say, a wash made of lime; but under the influence of the air, and any emanation from sinks —that is to say, all foul gases—wash made with lime is apt to turn black, and although it has done its work as a purifier by neutralising the foul matter floating about, its whiteness has gone, and its former beautiful appearance is altogether lost. Another kind of mixture is therefore generally substituted for limewash, and this substitute is whiting, a pure white earth that is moulded at the place where it is prepared into large irregular lumps, in which state it is kept and sold by oil and colourmen.

Preparation of Whitewash.—There are different modes of preparing whitewash from whiting. One way is to place it in cold water over night and allow it to soak till the morning, when the ingredients may be incorporated by stirring until a smooth, cream-like mixture is produced. A little strong size should then be made, and mingled with the whitewash to the extent of ½ pint of size to a gallon of whitewash. The presence of the size prevents the whitening from coming off when dry on anything that may be drawn against it in passing. It is generally supposed that whitewash prepared in this manner is durable, and will never rub off, but no whitewash, however strongly it may be sized, will stand in a damp position, or where it is exposed in any way to the action of damp. Dampness in the air, technically speaking, *kills* the size, that is to say, deprives it of its binding power, and as soon as this is destroyed the whiting will come off on anything that comes in contact with it. Another method of making whitewash with whiting is to mix as many balls or lumps of whiting as may be required with as much water as may be needed to reduce it to a thick paste; about ¼ lb. of hot size may then be added for every lump of whiting that may be used, and with the size, which should be hot, a small quantity of blue-black should be thrown in, which, when incorporated with the mixture, makes it a "good colour," as it is called.

Another method of making whitewash, which is strongly recommended, is to make a barrel or other suitable cask clean and water-tight, and put into it half a bushel of lime. Slake it by pouring water over it, boiling hot, and sufficient in quantity to cover the lime to the depth of five inches, and then stir the whole briskly until the lime is thoroughly slaked. Then add

two pounds of sulphate of zinc dissolved in water, and one of common salt. These ingredients will cause the wash to harden and prevent it from cracking, which gives an unsightly appearance to the work.

For whitewash to cover 100 yards superficial once over, 12 lb. of whiting will be wanted with ½ lb. of blue-black and 1¾ gallons of size. To go twice over the same superficial extent, 21 lb. of whiting, ¾ lb. of blue-black, and 2¾ gallons of size will be required.

Coloured Washes.—Whitewash is very good for the ceilings of basements and all dark places, because it reflects the light, and by lighting up the room imparts more cheerfulness to its aspect, and renders it all the more fit as a habitation. For ceilings of lofty well-lighted rooms, however, whitewash is too bright and dazzling and it has been found advisable to subdue its brilliancy by the addition of a slight quantity of colouring matter, or to relieve the broad unvaried expanse of white by lines of colour in the cornice, and by a stencilled pattern in some light and pretty tint that is repeated in the paper, or which forms the ground-work of the walls. For example, a white or very pale blue ground, with a stencilled pattern in darker shades of blue, looks very cool, chaste, and pretty; while in a room fronting the north, or some other equally cold and dark quarter, a warm grey, enlivened with stencilling in crimson of different shades or Indian red, will look very well. The old fashion of stencilling walls, it is to be hoped, will yet more and more supersede wall-papers.

Any required tint can be given to whitewash by the addition of a little colouring matter. Thus, for example, a beautiful *cream colour* may be produced by the admixture of yellow-ochre, or a good *pearl* or *blue-grey* tint may be obtained by the addition of a little lamp-black or ivory black. A good *fawn colour* is made by adding four parts of umber, one part of Indian red, and one part of lamp-black to the whitewash. A *stone colour* is made by adding yellow-ochre with a very small quantity of blue-black, and the cream colour above mentioned may be deepened to *straw colour* or *buff* by using more yellow-ochre. *Warm tints* may be imparted to whitewash by adding a little blue-black, or indigo, or orange red, or Venetian red. Any shade of pink or salmon colour may be made by vermilion; cobalt will give a *blue* or *French grey* according to the quantity that is used, and *green* may be produced by mingling indigo and yellow-ochre, more of the former being used when a *blue green*

or *dark green* is wanted, and more of the latter when lighter tints of green are desired. Sulphate of iron will also give a warm tint to whitewash. For interior walls the use of colour is desirable, but for the outside walls nothing more should be done than give the wash a warm tint by the admixture of some of the colouring substances mentioned above. A *yellow* or *grey* wall for the exterior of a building is not nearly so pleasing to the eye as plain whitewash, or whitewash sufficiently tinted as to take off the extreme brilliancy that accompanies a pure white surface; nor does it afford so good a background for trees, shrubs, creepers, and climbers.

It must be remembered that the more the whitewash the more will be the colouring matter required, and the amateur must also recollect that the colour will look far darker when wet in the pail than when dry on the wall. To decide on the precise tint to be used, and to bring the wash exactly to the colour required, whether light or dark, it will be necessary to put a little with a small brush over a piece of white paper and allow it to dry. When dry, the colour of the wash will be shown as it will dry on the wall. If too dark, a little whitewash must be added by degrees to bring down the original preparation until the desired tint is obtained; and if too light a little more colouring matter must be added, sparingly and by degrees, until a satisfactory result is produced.

Method of Mixing Washes.—Lastly, it is necessary to repeat that care is needful, not only in cleaning a wall or ceiling for the reception of colour, but in mixing the colouring solution itself and applying it. The whitewash itself should be carefully mixed, the preparation being carefully stirred together with a round smooth stick or a wooden spoon of large size, until the water and whiting are thoroughly incorporated; and then the size should also have its share of stirring, and the colouring matter the same, so that no lumps may remain at the bottom of the vessel unmixed—an oversight which will tend to make the last part of the mixture somewhat darker in shade than the first used from the same pail. It is necessary, too, to stir up the wash, whether white or coloured, every now and then while using it, as the heavier particles held in suspension by the water have always a tendency to sink to the bottom and settle there.

There is moreover a method to be observed even in the mode of applying the whitewash or colour wash. Not too much of the wash should be taken up at one time with the brush, as when

the brush is overcharged splashing is the inevitable result. The strokes of the brush should all be backwards and forwards in one direction, as the lines traced by the hairs of the brush will generally show in which direction it has been moved. Ceilings should be brushed the long way of the room, and walls straight up and down.

Lest there be any doubt as to where colouring matter for coloured washes may be obtained, it may be as well to say that the pigments can be purchased in powder of any oil and colourman, ready for use. To ensure the absence of lumps, it is as well to pulverise every bit of the colouring matter to be used before adding it to the whitewash, and as an additional safeguard to strain the mixture through a coarse cloth.

As a final word of advice to the amateur it may be said that the great secret in whitewashing, or applying any wash, white or coloured, is to do the work quietly, slowly and deliberately. Energy in such a proceeding is simply thrown away. It is necessary, too, that unless the amateur artisan has a dress expressly for every kind of work which involves dabbling with lime and mortar, he should have his clothes protected from injury by a white canvas slop and overalls of the same material. It will also be well to wear a cap of linen or paper.

CHAPTER VIII

METAL WORK—SMITHS' WORK AND FITTING

Smiths' Work.—In smiths' work, and indeed in all kinds of metal working, the amateur artisan will not do much, owing to the many difficulties that must be encountered and overcome, the cost of the apparatus required, and the time and practice required to become even moderately efficient in these handicrafts. Indeed, it may also be said that whatever he does in metal work will be chiefly in the way of repairs.

But as many, however, may wish to know what are the chief operations in smiths' work, it is desirable briefly to describe them. It will be useful for example for every amateur to have the appliances and the knowledge requisite for doing such simple forging as is involved in heating and hammering out a piece of iron to any form required for the repair of ironwork in the house or garden. It is also desirable for him to know something about

casting, fitting, and drilling; and the descriptions of these processes may be supplemented by instructions in the simpler ones of riveting and of mending and cleaning locks and fitting keys to them.

Forging: What it is.—Forging, which must first claim our attention, relates to the fashioning *wrought-iron* into such shapes as necessity or fancy renders desirable. The actual manner of handling the metal can only be learned by observation and practice. A few instructions, however, may be given to the amateur which will render easy the acquirement of the practical knowledge, and these may be commenced with a few words about the fire, which is the first consideration.

A common kitchen fire, if clear and bright, will answer for some few simple purposes, but to successfully perform most of the principal operations requires a far higher degree of heat than can be got from a common fire. This heat is obtained by blowing air through the coals by means of fans or bellows. The former are used only for large work, and are driven by steam or other power; these, therefore, are of no use to the amateur, whose wants in this respect will be best supplied by a small forge of the hand-bellows class.

A portable forge of the ordinary form consists of an iron table surrounded by a ledge on all sides, and supported on an iron stand. Below the table on which the fire is made are the bellows, worked by a rod attached at one end to the bottom of the bellows, and at the other to a handle by which it is alternately raised and depressed, thus opening and closing the bellows in turn, and causing a rush of air to the fire through the pipe, through the orifice of which the air is ejected. Into this hole a short pipe or tuyere may be screwed so as to act as the nozzle of an ordinary pair of bellows, and carrying the blast into the centre of the fire.

The fuel used is fine coal, generally called "smiths' coal" or "slack." A few ignited ashes being put on the table near the bellows' hole, some fuel previously damped put on this, and the bellows worked up and down, the fire will soon get very fierce. It can be moderated by merely stopping the supply of air, and it will remain alive for a great length of time after the blowing is stopped, a few strokes of the bellows soon bringing it up to a good heat again when it is required. The fire occupies but a small part of the iron table. The ledge is useful for supporting the tongs and any tool that the amateur may be using when laid down for a moment, as well as for preventing any particle of red-

hot fuel from falling on the ground below. It is often necessary in forging to plunge the heated iron into water as soon as it is withdrawn from the fire, and for this purpose some water should be at hand. A smith has a large tank close to the forge, but an iron pail filled with water will be sufficient for the amateur.

Amateurs who live in towns and who wish to have a small forge that has the merits of being perfectly clean, without trouble either in lighting or use, and always ready for instant use, should provide themselves with one of the handy little gas forges or brazing hearths now obtainable commercially. The entire apparatus is supplied complete with blower, blow-pipe, hearth tools, and tubing, and if required a suitable hood can be fitted. All small heating and brazing work can be done with these forges.

The Smiths' Anvil.—Next in importance to the forge is the anvil, on which the heated iron is beaten to the shape required. This should be close to the forge, so that the iron may be taken out of the fire and placed immediately on the anvil while it is still in a red-hot state, and in that condition in which it yields most easily to the blows of the smiths' hammer. The anvil is supported on a large block of wood in order to bring the upper surface within easy reach of the worker when standing. It has a flat surface or "table" at top slightly raised, which, in the better class of anvils, is made of steel. At one end projects a cone or beak, rounded and tapering almost to a point, over which iron can be rounded. The use of the beak will be best seen when the reader considers the shape of a horseshoe, and how difficult it would be to bring it into this form without some appliance of the sort. In the table is a square hole, which serves as a socket, into which various tools may be fitted, one of the most common being a chisel on which a rod or bar may be placed and cut to any required length. Anvils may be had, varying in size and weight, from 28 lb. to 4 cwt. The amateur may pick up one well suited for his purpose at a marine-store dealer's.

Tools Required.—The tools that are mostly required are a hammer, a chisel for cutting iron, and tongs for handling red-hot iron, and for placing iron in the fire to be heated, and for withdrawing it from the fire when hot. To these may be added a few rasps, files, etc., the use of which the amateur knows sufficiently well to render it unnecessary to say any more with reference to them than that they will often be found requisite in filing down any piece of work, or reducing the surface of a welded joint when it may be a little too thick. Of course a smith has an infinite

variety of tools, but these will be all that an amateur will require in an ordinary way.

The tongs most commonly used by the smith in forging are made of iron, of any size to suit their work, and on the same principle as the carpenter's pincers, which they resemble to some extent. Their use is to hold a *short piece* of iron whilst forging it, to return it to, and to remove it from, the fire. When heating and beating out one end of a long bar of iron to any required shape, the other end may be held in the hand without the use of tongs.

The hammer required for smiths' work or forging is generally double headed. It weighs from three or four ounces to as many pounds, different weights and sizes being required for different kinds of work. The amateur will find that one weighing about one pound will be the most suitable for his purpose.

The smith's chisel is not the chisel that is placed upright in the socket made for its reception in the anvil, but one which may be held with a handle in the same manner as the hammer. A deep groove runs round one end of the chisel. A hazel rod is often bent round the groove and the ends twisted together like the strands of a rope, thus preventing the jarring of the hand and arm, which is felt when the chisel is held by an iron handle, especially if the blows delivered on it are heavy. In cutting a thick bar of iron, one man generally holds the chisel while another strikes it with the hammer.

These tools, as it has been said, will be sufficient for all ordinary purposes, because forging is a branch of work which cannot be gone into very fully by the amateur without skilled assistance. The amateur, it may be repeated, should only attempt simple jobs ; beyond effecting these, the chief use to him of a knowledge of forging will be to renovate and repair his steel tools, and for this purpose it will be extremely useful.

Both iron and steel for forging purposes can be purchased either in round, square, or rectangular bars, or in sheets.

Forging, Ordinary Operations in.—Some general instructions may now be given with regard to ordinary operations in forging, one of the principal of which is "drawing out" iron, and another "welding;" processes which must now be described.

The iron must be made hot in the forge, and beaten or hammered out into the required shape upon the anvil. The proper heat for iron when it has to be *drawn out*, that is, beaten out into a point, or made smaller, or worked into a different shape, is a bright red. For *welding* or uniting two pieces of wrought iron

by laying the ends one upon another and hammering them, the heat should be what is called a "welding heat," that is, a white heat, so hot that if made hotter the iron would melt.

Let us take two very ordinary operations for illustrating these processes. There are two pieces of wood at right angles to each other, and it is desired to give strength and support to the upright by connecting it with a horizontal piece, by means of an iron stay. A piece of iron bar having been procured, about $\frac{5}{16}$ in. or $\frac{3}{8}$ in. in diameter, the ends are successively heated to red heat and bent to the required angle, and beaten out flat beyond the bend. Holes for the admission of screws are punched in the iron, when it is red hot, or bored with a drill. If the amateur has a drill the better plan will be to use it, and afterwards deepen the holes on the outside with a counter sinker; if he has no drill, he can punch the holes, reduce the burr caused by punching with a flat file, and afterwards clear the holes thus made, or work them to the requisite size with a rat-tail file.

Again, to illustrate welding, let us suppose that the amateur has broken the centre line or prong of his garden folk; a piece of iron of the requisite width is obtained, and the fork, and the piece of iron to be added are both heated to a white heat. The fork is then placed on the anvil, and the new piece is laid on the broken prong by aid of the tongs, and the two pieces are incorporated by a few sharp blows of the hammer. The iron must then be placed once more in the fire, brought to a white heat, and the process of beating repeated, to bring the two pieces of iron completely together. When this has been done, the end of the new piece can be heated and drawn out until similar in appearance to the other prongs. It must be noted that only *wrought iron* can be dealt with in this way; cast iron articles when once broken cannot be united or mended so as to be serviceable again.

It may further be of advantage to the amateur to explain the process known as "upsetting," and also how to put a collar on a bar of iron.

"Upsetting."—When a piece of iron or steel is wanted with an enlargement at one end, or at both ends, or when a bulge or thickening is required in the middle, the place where it is wished to form the lump is made bright red, and the end of the iron is then brought down on the anvil with great force, the bar being occasionally hammered a little to keep it straight. Any operation of this kind is technically called "upsetting."

Steel, Manipulation of.—Steel is far more difficult to deal with than iron. The amateur will not be able to weld steel, but it can be "upset" without difficulty. Great care must be taken never to heat steel more than cheery red; if raised to a white heat it is utterly spoiled for most purposes. Steel has the peculiarity of becoming very hard when raised to a red heat and suddenly cooled. It then becomes so very hard that no file or cutting tool will "touch" it, or make any impression upon it. After forging steel, if it has to be turned or filed, it should be annealed by making it red hot and allowing it to cool very gradually. For some purposes merely burying it in the ashes of the forge will suffice, but for others the steel must be buried in charcoal or sawdust, enclosed in an iron box, the whole raised to a red heat, and allowed to cool gradually without exposure to the air. It can at any time be hardened by raising it to a red heat, and suddenly quenching it in cold water or oil; the former method is cheaper, but the latter is better; either, however, will do. Very small steel drills are hardened by heating them in the flame of a candle, and suddenly plunging them into the grease or tallow of which the candle is composed. Thin sheets of steel, if heated and plunged in water, are almost certain to warp or crack; they are therefore hardened by laying them, whilst red hot, between two cold pieces of iron.

Tempering Steel.—When steel is hardened in this manner it is much too hard to be serviceable for most purposes, it must therefore be "tempered" or partially annealed. This is effected in a variety of ways. For cutting-tools, the best plan of tempering is to rub the already hardened steel in brick, or to grind it until bright, and then lay it upon a large piece of red hot iron until it is of the desired temper. The temper is easily known by the colour, because after it has been in contact with the hot iron for a few minutes it will gradually become a light yellow or straw colour; and if the steel is a tool for cutting iron, it should then be quenched in water. If the steel be left on the iron, its tint will gradually get deeper until it is a purple colour, which is the colour for brass-turning tools; a little longer and it will become a light blue, which is the right temper for wood-turning tools. If allowed to get too low in temper or too soft, the steel can be hardened afresh and again tempered. The temper required may thus be secured with the utmost precision, as the gradual change of colour in the metal shows most distinctly every degree of oxidation from one end of the scale to the other. All that is necessary is to watch the changes of colour with attention, and when the right shade has

been reached to remove the steel from the iron and plunge it into water.

Case-hardening Iron.—Iron in itself has not the property of becoming hardened in this manner. It may be heated to any extent and dipped in water or oil, and when taken out is very little harder than before; but by using certain chemicals or compositions it may be hardened on the surface, or, as it is technically called, "case-hardened."

The case-hardening of iron is effected by making the iron red hot and rolling it in powdered prussiate of potash. The iron is then returned to the fire until the potash melts or gets creamy; it must then be suddenly cooled by immersion in water. Another way of accomplishing the same object is to burn some scraps of leather or bones, then wrapping the iron to be hardened in this and raising the whole—for iron, charcoal, and all must be put into an iron box, the charcoal completely covering the iron, and plunged into the fire—to a bright red heat. It is kept at this heat for a period varying from 1 hour to 8 hours, according to the depth of case-hardened metal required. The iron is then taken from the fire, removed from the box of animal charcoal and quenched in water. In this method, should it be of importance that certain parts of the iron are hardened while others are left soft, those parts required to be soft must be wrapped round with stiff clay.

Brass and Copper may be drawn out but not welded.—It is not possible to weld either brass or copper, but both admit of being drawn out under the hammer. To do so they are warmed and suddenly quenched. This has the power of softening them—just the contrary result to the effect of the same operation on steel—hammering rendering them soft and brittle.

Patterns for small Castings.—The method of making patterns for castings has been explained in another part of this work, and with the manufacture of the pattern the amateur is advised to be content, sending the pattern to the iron-founder or brass-founder to have the casting made. It may, however, happen that, through one circumstance or another, the amateur may require to make some small casting for himself, and in order to render him some assistance in doing this the method may be briefly described. In doing this we must consider the mould and how to make it, the metal and how to melt it, and lastly the casting and how to finish it.

Melting the Metal for Mould.—We must consider that the pattern has already been made, and in this case the mould must be made of sand. In casting or founding, the metal, whether it be iron, brass, gun-metal, bronze, or lead, must be made quite fluid, after which the molten stuff must be poured into the mould made to receive it.

Moulds for Small Leaden Castings.—Very small articles in lead are sometimes cast in wooden moulds, two pieces of hard wood being prepared, having one side of each perfectly true or flat, so that when brought together they will make a good joint. Half the shape of the article to be cast is then cut out from each piece, and, of course, when the two pieces of wood are put together, the two *halves* of the mould must correspond exactly, or come opposite each other so as to make one *whole*. A passage must be also cut for the entrance of the metal into the cavity within. When ready the two pieces are firmly clamped together, and the molten metal poured into the mould. The hot metal will, of course, burn the wood, and after two or three castings the mould will be spoiled.

Moulds of Stone and Flanders Brick.—Stone moulds are more durable. Of course stone is more troublesome to work than wood, but if a soft, sandy stone is selected, the amateur will not have much difficulty in making even an intricate mould. Flanders brick will also answer well for the moulds of some castings. When a great number of small castings of the same size are wanted, iron is generally resorted to as the best substance for the moulds. It is very difficult to work iron to shape, but when the mould is once made there is no limit to the number of castings that can be made in it.

For the more fusible metals, moulds made of plaster of Paris are often used. It is not suitable, however, for the more refractory metals, as the great heat causes it to crumble and lose its shape.

If the mould is large it must be warmed and held over the flame of a candle, or, what is better, the flame of resin dust wrapped in brown paper. This will cover the face of the mould with a thin coating of soot, the effect of which will be to prevent the liquid metal from adhering to the mould. A fresh covering of soot should be given to the mould after every six or eight castings have been made in it. When engaged in this kind of work some workers dip the mould in water to cool it quickly. This is extremely dangerous, as, if a drop or two of water remains in the mould, the water will suddenly be converted into steam when the

metal is poured in, and the lead forcibly expelled from the mould, perhaps flying into the face of the operator and severely burning him. The amateur should always carefully dry his mould, whether made of iron or any other material, before the metal is poured into it.

Sand-moulds.—For general castings, by far the best moulds are those made of sand, and called sand-moulds. In order to make a sand-mould, a pattern is made the size and shape of the desired casting in the manner described in a previous chapter. The material used is of three sorts, namely moulding sand, facing sand and parting sand. Of these, moulding sand is a mixture of common sand and sufficient clay, or loam or other binding material to enable it to hold together. Facing sand is ground or fine moulding sand; the parts of the mould which will come in contact with the metal are made of this. Pea-meal, flour, whiting and charcoal, are sometimes dusted over the mould as a facing. All excess of this dusting should be removed by the aid of the bellows. Parting sand is generally made of red brick dust; this is dusted over the joints of the mould to *part* them, or prevent them from adhering to each other.

Moulding Tools.—The tools required by the amateur are few and simple, and such as he may easily make himself. Moulding flasks are skeleton boxes, or boxes without top or bottom. They are generally made of iron, but wood will answer for a makeshift. They are in two parts, and are furnished with ears or laps, the laps to the upper flask having pins projecting downwards, and the laps to the lower flask perforations corresponding to the pins to receive them. The trowel is a blade of thin steel, set in a wooden handle. The wire is simply a piece of iron wire or narrow iron plate, bent and fashioned to a convenient shape. It is useful for smoothing corners, removing dirt from the mould, and so on. Runner sticks are pieces of round taper wood about 6 in. long. They are used to make the holes necessary for running the metal into the moulds. The stamper is a blunt-ended piece of iron or hard wood, very much like a pestle. It is used for stamping the sand into the shape of the pattern.

Process of Moulding.—The process to be adopted in making the mould is as follows:—Supposing that we want to cast anything in metal, we must take the pattern that has been previously prepared, and lay it flat upon a level board. The pattern must

be buried in sand exactly to the extent of one half; the bottom part of the flask must now be put ears downwards over the pattern, and sufficient facing sand thrown into the flask to cover the pattern. On this place some moulding sand; press and stamp the sand well into the shape of the pattern; lay on some more sand and well ram it down, continuing the addition of sand and stamping until the flask is full. Then carefully reverse the flask and put the pattern upwards; with the trowel and wire trim off the sand, and press it well along the edges of the pattern. Exactly half should now be imbedded. Put on the top flask so that the pins go into the holes of the under one, dust over the sand with parting sand; bury the pattern in facing sand, put the small end of two running sticks through this sand, and let them touch the pattern and stand upright; throw in some moulding sand, and press, stamp, and ram in the same manner as before until the flask is full. Withdraw the runner sticks, carefully take off the top flask, remove the pattern very carefully —damping the sand immediately surrounding it will make this easier of accomplishment—repair any broken edge, clear the mould of all loose sand, and put both parts before the fire until quite dry. When the top flask is put on in place the mould is ready for the metal. If a mould is to be made for an article such as a cylinder through which a square hole is required, in the direction of its axis, the mould will present the form of a solid cylinder with a triangular groove in each half, together making up the square hole formed by the prints. In this case take a piece of Flanders brick and rub or file it square, the size of the hole required, and lay that in the mould, each end fitting the square groove made by the print. Half the core fits into the under flask, and when the top flask is put on the other half of the core fits it. When dry the moulds are ready to be used. Of course, when the metal is poured in, it will fill all the mould except that part occupied by the core. This will not burn, and can easily be knocked out of the casting in which there will then be a smooth square hole.

Iron Castings.—The skin or "scale" of an iron casting is, in consequence of the hot metal being chilled by contact with the mould, much harder than the inside. Sometimes it will be so hard as to spoil the files or other tools that are brought into action upon it. Should this at any time be the case, the scale should be either ground off, or removed by immersing the casting in a bath of sulphuric acid and water for a couple of days, and

then very little difficulty will be experienced in working the casting into shape.

Metals used for Castings.—Various metals are used in making castings, the most common being iron, gun-metal, and brass. With regard to the composition of metals the following proportions will be found useful for castings of gun-metal, bronze and brass.

Gun-metal.—Copper, 88 per cent.; tin, 10 per cent.; zinc 2 per cent.

Bronze.—For bronze castings the following is a useful composition:—Copper, 88 per cent.; Tin, 12 per cent.

Brass.—For brass castings the following is the mixture:—Copper, 66 per cent.; Zinc, 34 per cent.; or, should the brass be required for turning, Copper, 62 per cent.; Zinc, 37 per cent.; Lead, 1 per cent.

Crucibles.—The metals composing the mixture must be melted in a crucible or melting pot; these are sometimes made of clay, but those made of pure black lead, called plumbago crucibles, are preferable. They can be had in all sizes, the price varying according to the size. When these leave the maker's hands they are unannealed, and rapidly absorb moisture from the atmosphere; if, therefore, the first time of using, the heat is raised rapidly, they are certain to crack or "fly." This, however, can easily be prevented by annealing them. This is done by putting them first into a common oven; when taken from the oven they should be put over a slow fire, and then on a fire where they can get thoroughly red hot. They can then be used whilst hot, or allowed to cool for future use at any time when required. No further annealing or precaution is necessary, but they can be used until they are worn out. They can generally be used for 20 or 30 heatings.

Melting Metals.—The heat required to melt the metals is very intense. A common fire is not sufficient, but the heat can be obtained in the fire made on the portable forges already mentioned. The best way to make a fire for this purpose is to make a small fire first, level it, and put on the pot, then lay the coal all round it until level with the edge and in the shape of a pyramid. A strong blast should now be applied by means of the bellows until the pot is red hot; throw in the metals and continue blowing until they are quite fluid. Then the pot should be taken from the fire by means of an iron hoop with one or two bars projecting from it, and the metal poured into the runner holes of the mould.

A stick should be held to the lip of the pot, so as to keep back the scum and prevent it from running into the mould.

If the mould has been well made and is nice and smooth, the metal well mixed and quite fluid, and the pouring skilfully and carefully conducted, a good casting will be the result. But although the casting may be smooth, free from blow-holes or not honeycombed, sharp and straight with regard to its edges, and, in short, *as a casting*, thoroughly well made, it is still much too rough and uneven to be used as the working part of any model, or as part of any machine or contrivance that is expected to work evenly and smoothly. All castings, indeed, must be rendered fit for service by fitting and turning in the lathe.

Turning and Fitting.—With regard to turning, the principles and the processes employed are similar in many respects to those described in connexion with wood-turning; the tools and aids also are much the same, though adapted to suit the hardness of the material to be turned. Fitting consists in suiting the various component parts of a machine one to another, drilling the holes that may be required, filing and polishing those parts which are exposed to the view, or those which ought to be neat and smooth. The fitter also files and brings to a true surface, such parts of a machine which slide or work in each other.

Tools required in Fitting.—The principal tools required in fitting are a vice, files of different sorts, cold chisels, straight-edge, scribe, bevel, hack-saw, scrapers, and surface plates. We will finish our necessarily brief account of casting and fitting by a description and illustrations of some of these tools.

Vice.—Vices for use in both wood and metal work have been fully dealt with in the first section of this work (see p. 67–8).

Files.—The various sorts of files have also been described (see p. 45). The kind chiefly required by the amateur fitter will be a three-square file for roughing-down or taking the scale off a casting. Of this sort the amateur will want a 14 in. bastard-cut and a 10 in. second cut. Square files are used for filing out square or rectangular holes; of this kind of file a 6 in. and 4 in. will be found of great and frequent service. In addition to these, the amateur should possess one 6 in. round parallel file, and a 12 in., 8 in., 6 in., and 4 in. round taper file for filing out or enlarging holes, filing curved corners, and so forth. Several sizes of the half-round file of the finer cut should be purchased, as its peculiar formation renders it

suitable for flat, curved, or angular work; and an 8 in. smooth, and a 6 in. and 4 in. dead-smooth flat parallel file should be added to the stock, which should also include two or three thin warding files, and the same number of small triangular saw files.

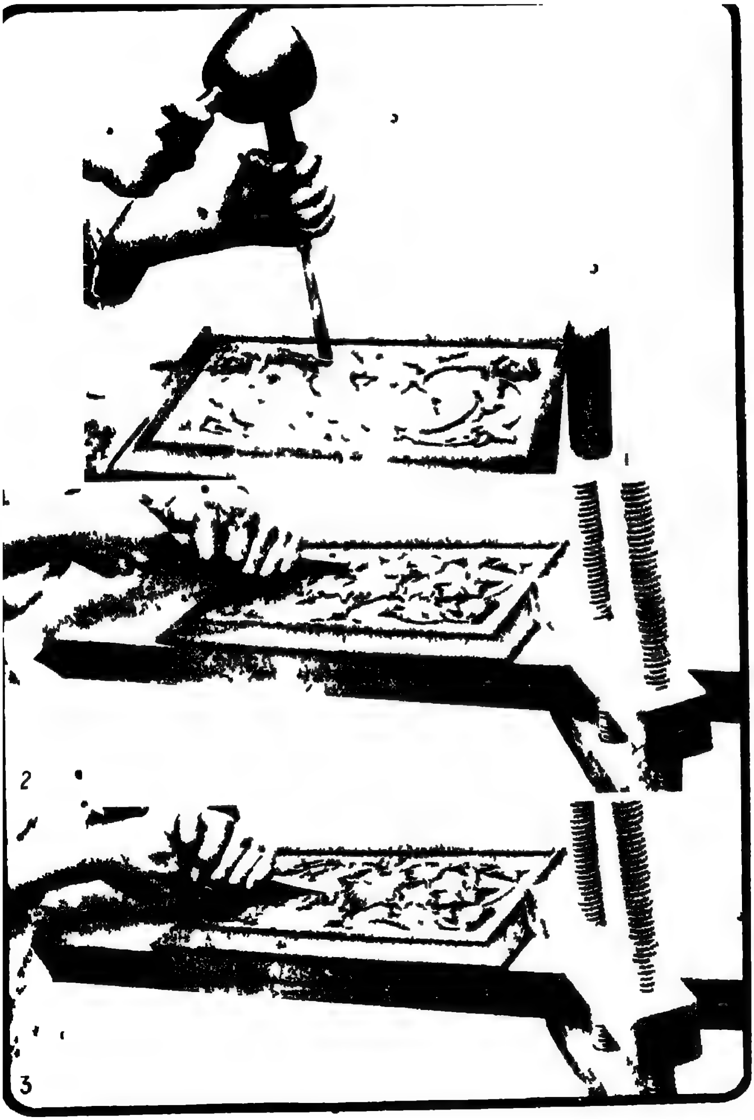
Fitter's Hammer.—The fitter's hammer is of the form technically known as a cross-pane hammer; it should weigh about 14 ounces.

Chisels.—The chisels used by the fitter are different from those used by the carpenter and joiner, being solid and made entirely of steel. The cutting edges are ground off part from each side. They are tempered until the *edge* is a bright yellow. Should they happen to break, they can easily be drawn out at the forge, retempered, and ground.

Other tools required by fitters.—The *square* used in fitting is similar to that used in wood-working, but it is much smaller, and made wholly of steel. The amateur fitter will also require *callipers*—an instrument already described in connexion with Carpentry and Joinery, (p. 80) for gauging the width and size of a piece of metal which is required to be parallel. The *straight-edge* is made of steel, and is used to apply to a piece of metal to test its straightness and evenness of surface. The *scriber* is a piece of steel looped at one end and pointed at the other, like an iron skewer. It is used for marking lines on metal. The *bevel* is something like a square, but the blade is movable so as to be set at any angle. It is kept from altering by tightening the screw; it is made of steel. A description of the *hack-saw* has been given on p. 45. The steel *scraper* used by engineers is required for removing inequalities on the surface of the metal work left by the file or by other cutting tools, and for making steam, or air-tight faces or joints. The *surface-plate* is generally made of cast iron. Its top is a perfectly true surface, and its edges are square with the top and with each other.

How to use the File.—The enumeration and description of the tools used by the fitter may be supplemented by a short account of the process of chipping and filing. When we desire merely to make the surface of a piece of metal smooth, the metal must be put between the jaws of the vice, and firmly held there by turning the screw and bringing the jaws tightly against the article between them. A rather rough file, furnished with a handle, must now be taken and passed evenly over the surface, the handle held in the right hand, the left pressed upon the point of the file. The

Plate XXVII WOOD-CARVING



1 Settin in [illegible] Veinin [illegible]

Plate XXVIII BRICKLAYING

(1) Use of a level (2) Use of plumb

best position for standing is with the left foot advanced. The file should be pushed forward slowly, the whole length being used and brought back lightly or touching the work [illegible], the work being done by the forward stroke. It should be remembered that owing to the manner in which the file is cut the only effect of pressure on the return stroke is to destroy the teeth or cutting points.

Chipping, Chiselling and Filing.—We will suppose, to illustrate the process of chipping and filing, that a block of iron is required,—that we have the casting, but that it is somewhat too large; also, that is it of importance that it should have flat sides, and every side exactly square with the others. Fix it firmly in the vice as in Fig. 3, Plate XI; take the hammer in the right hand and the chisel in the left. Place the cutting edge of the chisel against the edge of the block, as shown in the illustration, and strike some fairly heavy blows upon the top of the chisel in rapid succession, until the whole of the scale on one side of the casting is chipped off. When this has been done, let the amateur fitter take the largest file he has and shoot it across the surface of the iron, filing away until the chisel marks are removed. Then apply the straight-edge to the surface. If not straight, but in the form of a slight curve, higher in the middle than at the edges, try again, keeping the right elbow down and pushing the file forward in a straight line, instead of allowing it to move up and down as most beginners will. When the point of the file is put to the work, press heavily with the left hand and lightly with the right. As the file is pushed forward, gradually relieve the pressure from the point of the file and press more upon the handle. When the file is at half-stroke the pressure upon both extremities should be equal, and at the termination of the stroke the pressure should be just the reverse of what it was at the commencement; or, in other words, the great pressure that was put upon the point should be transferred to the handle, and the light pressure upon the handle laid upon the point. When this side is filed straight, chip and file the remaining sides, frequently applying the square and straight-edge to the work in order to see where the metal should be removed in order that the desired shape may be obtained.

Drilling.—Another branch of the fitter's work consists in making holes through metal. To drill a hole through a thin piece of metal is very easy, and can be done with little labour, no skill, and very simple apparatus. Small holes through long

lengths require great patience and skill, and special machinery. The amateur will mostly require to drill holes in thin metal, so it will be sufficient for all general purposes to describe the tools that are absolutely necessary for making these.

The rotary motion necessary in drilling can be given either to the tool or to the material through which the hole is required; for general work the tool is usually put in motion whilst the article is stationary. All holes, whether small or large, should have their position marked out, and an indent or centre mark made exactly in the centre of the place where the hole is required. This centre mark, which serves as a commencement for the hole and a guide for the drill, is made with a centre punch. In using this tool the point must be placed on the spot requiring the mark, and a smart blow with the hammer given upon the head. This will cause the point of the punch to sink into the metal, and when it is withdrawn a circular indent will be seen of a depth corresponding to the nature of the material and the weight of the blow.

Drills present considerable variety in size and shape, but those commonly used by fitters are square and taper at one end, and flat and thin at the other. The thin end is ground to a point so that the cutting edges are at right angles to each other, and also a little is ground off each side of both the edges of the angle in order to provide clearance and allow for the escape of the metal removed. For all work, however, requiring accuracy, the morse twist drills, to which reference has already been made (p. 65), are much to be preferred. Their working capacity is also much greater. The disadvantage of these drills is the difficulty experienced in properly sharpening them.

Of the many contrivances for giving a rotary motion to the drill, those used by the amateur will be generally for small drills, the Archimedean drill-holder (p. 65), and for the larger square shaped drills the ordinary bit stock also used by carpenters and joiners; for the Morse twist drills the ratchet hand drill holder described on p. 65 will be found the best.

Holes can be drilled through brass, gun-metal, cast iron, etc., without the use of any lubricating material, but wrought iron and steel must be kept well moistened with oil.

Counter-sinking Holes.—It is frequently necessary to countersink a hole, that is, to enlarge its orifice in the shape of a V. This is done by aid of the counter-sinker, shown in Pl. IX,

which is worked in the hand-brace. Sometimes it is desirable to recess a hole, and make it larger with a flat bottom. This is done with the pin drill. The pin at the end of the drill being the size of the small hole, keeps the drill central.

The amateur who has made himself acquainted with the various processes in metal work described above, will find many opportunities for putting into practice the knowledge he has acquired.

Repair of Locks.—Nothing about a house gets out of order quicker than the locks of doors, especially if cheap locks have been used. The simple latch fastening used for garden doors and doors of out-buildings generally—which consists of a bar secured to the door by a pin thrust through one end, the other being lifted by a short lever or by a knob attached to the bar—is so simple in its construction that it needs no detailed description. The manner of fitting the various forms of locks has been explained in the section of the work on Carpentry and Joinery (p. 298). It will be useful in the present chapter to describe and illustrate the principles on which locks are made, and to consider the chief causes by which they get out of order.

The simplest kind of lock that can be made is the common cupboard lock. In this and in all other locks used for doors the interior is concealed from view by a plate fastened on to two more projections from the thin strip of metal which forms, as it were, the side of the box in which the key works, and through openings in opposite sides of which the bolt is moved backwards and forwards. The bolt or bar is cut deeply lengthwise at the upper part of one end, so that the part partly separated from the bolt may form a rough kind of spring which presses upwards against the frame of the lock. At the lower part of the same end two notches are cut which work on the frame-work, each notch fitting or slipping on to it alternately as the bolt is moved backwards or forwards by the key. Midway in the lower part of the bolt is a semicircular notch in which the key acts to shoot the bolt backwards and forwards. The key, which is tubular in form, fits on to a pin projecting from the lock-plate, and the slits or nicks in the projecting part of the key fit over curved pieces of iron or brass called *wards*, which are fixed to the lock-plate in the form of circles or parts of circles round the pin on which the barrel of the key fits as a centre. To lock the door the key is turned to the left hand, and the projecting part strikes against the left-hand side of the notch pressing the bolt

forward, and compressing the spring to an extent sufficient to allow the first notch at the lower part of the bar to the right hand to be raised off the frame of the lock, on to which the second notch slips as soon as the bolt is shot forward far enough to release the key.

The Tumbler Lock.—A lock of better and more complicated construction is that known as the back-spring *tumbler lock*. In this lock the bolt is hollow on one side, so as to allow the tumbler or catch which secures the bolt to be placed behind it. It is fixed to the lock-plate by a pin, and is pressed downwards by the action of a spring. On the end of the tumbler is a projection which fits into one of the notches in the bolt according to the position of the bolt. There is a semicircular notch in the lower part of the bolt about the middle, in which the key works. The projection before the key is turned to lock the door resting in the notch, and the first thing that is done by the key is to raise the tumbler. The effect of this is to raise the projection out of the notch. The key then presses against the left-hand side of the notch and shoots the bolt forward, when the tumbler relieved from the upward pressure of the key, is pressed down again by a spring, the projection falling into a second notch and retaining the bolt in its new position. In unlocking the door the process is reversed.

Locks for Doors of Rooms.—The locks used for the doors of rooms are mortise locks and rim locks, a lock in the form of a box similar to a rim lock but larger, being used for a front door. Rim locks are used mostly for bedroom doors, which, for the most part, are not thick enough to take a mortise lock; they are simply attached to the door on the inside by long screws, the catch and lock entering an iron box with a brass projecting edge, screwed on to the door jamb. Mortise locks are used for the thicker doors of sitting-rooms, a cavity being formed for their reception in the style and broad centre rail by means of the mortise chisel: the bolt and catch work through a brass plate screwed to the edge of the door and into cavities cut in the opposite jamb, and faced with a brass plate. Rim locks are to a certain extent a disfigurement to a door, but mortise locks are not so, as the lock is concealed within the rail and style of the door, the knobs on either side, and the accompanying furniture being the only indications of its presence.

The construction and working of the lock is similar to that of the tumbler lock already described. The catch above the

bolt is a long bar sliding easily backwards and forwards to the extent of about ⅜ in. or a little less, solid at the end where it projects from the door and bevelled at this end so as to slide easily over the bevelled brass rim of the box that holds it when the door is shut; at the opposite end is a bar at right angles to the bar of the catch itself generally called the tail of the latch. Behind this bar is a spring attached to the door-plate by means of a screw, pressing outward against the bar, and thereby keeping the latch out to its fullest extent, which is its normal position except when the door is being opened or shut. On the other side of the bar is a lever generally made of brass, the circular part of which projects through round holes in the plates of the lock in front and behind. In this circular part is a square hole through which passes the iron spindle, at each end of which is a door knob, fastened to the spindle by a small screw which goes through a hole in the collar of the knob, and enters a depression in the spindle, thereby rendering it impossible to pull off the handle as long as the screw remains in its place. When the handle of the door is turned to the left the upper part of the lever is pressed against the bar, which in its turn presses against the spring forcing it back. By this movement the end of the latch is withdrawn from the box that holds it, and the door is free to open. As soon as the handle is released whether the door be open or closed, the latch is again restored to its original position by the outward pressure of the spring.

It is not often that the lock itself gets out of order, and when this is the case it is generally owing to the breakage or some injury done to the small spring which must be replaced with another purchased from the ironmonger. Occasionally some foreign substance may get between the wards over which the key works, or the wards themselves may have suffered displacement, in which case the lock must be removed and the wards restored to their original position. With regard to the catch, there are three causes which will throw it out of order. The first of these is the fracture or weakening by long use of the spring which can always be replaced. Secondly, the lever may be slightly displaced by undue upward or downward pressure on the spindle that goes through it, and when displaced the softer brass will be gradually cut away by the harder iron within which it works, and after a while a new lever will be required. Lastly, the tail may be broken away from the main bar of the latch, in which case it will be necessary to braze the pieces together again. Locks are liable, on account of the dampness of the air at certain times

and the entrance of particles of dust, to get rusty and dirty inside, and in order that they may always work smoothly it is desirable that the amateur should at times take his locks to pieces and give them a good cleaning and oiling. All movable parts should be taken out and placed for some time in paraffin oil to loosen the rust, and afterwards cleaned with emery cloth. A few drops of sweet oil should then be put wherever there is friction.

The keys of mortise locks and rim locks are solid throughout, except where the wards are cut, while those of box locks, drawer locks, cupboard locks and rim locks are tubular, so as to fit over the pin which projects from the lock-plate. The solid stems of the keys of mortise and rim locks work in sockets formed in the plates of the lock. When a key is lost and the door happens to be locked, the lock—any warded lock—may be opened either by means of a skeleton key or what is technically known as a lock-pick. If the skeleton key will not pass the wards in the first place, the place of these may easily be found by coating the key with soft wax or soap, inserting it in the lock, and turning it against the wards. The impressions thus made will show exactly where the metal of the key is to be cut away in order that it may pass. Lock picks are simply pieces of strong steel wire bent so as to raise the tumbler and throw back the bolt of the lock. It is sometimes necessary to use at the same time a separate pick for each of these purposes.

To supply the place of the lost key another may generally be obtained without difficulty from the ironmonger. If a key will not exactly fit, a little filing of the wards with a thin flat file called a " warding file " may have the desired effect. The slots in the end of the key fit over wards projecting at right angles from the lock-plate ; when these are L shaped the horizontal slots at the top of each, *if there be any need for them at all*, passing over narrow flanges at the top of each ward. Another slot sometimes passes over a flange attached to the interior of a ward, *within* which the end of the key works, barely touching it if it touches it at all. The slots must be cut with very narrow warding files. Blank keys without any wards whatever which the amateur, with patience, can file and slot so as to suit and fit the lock, can be purchased at the ironmonger's. The outer plate of the lock should be removed so as to expose the wards and show where the slots are to be cut, without resorting to the expedient of ascertaining the position of the wards by taking the impression on wax in the manner described.

When the keyhole of a lock is worn away so that the key works

loose in the lock, the trouble may be removed by soldering or sweating over the hole a thin brass or iron washer which will just fit the stem of the key, and afterwards filing away the lower part of the washer sufficiently to allow the insertion of the key. It will generally be found necessary to file back the collar of the key to compensate for the thickness of the bush.

CHAPTER IX

METAL WORK—PLUMBING, GAS-FITTING AND BELL-HANGING

All kinds of work in sheet metal, such as zinc-working, plumbing and gas-fitting, require a knowledge of the processes of soldering and brazing. The edges of pieces of sheet metal are joined together by these processes, and it is as well that the amateur should know how to make a joint in metal, whether sheet or pipe, and possess the few appliances necessary for doing so. If he can do no more with regard to work of this kind than repair tin pots, kettles, etc., it will be of advantage to him, for the itinerant tinman is seldom at hand when his services are most required.

Soldering and Brazing.—Soldering and brazing may briefly be described as methods of uniting pieces of either the same or different kinds of metal with a strong and, if necessary, water-tight joint.

To effect this by *soldering*, an alloy called solder is used. This only is melted, the metals to be united not necessarily requiring to be heated before the operation of soldering is commenced.

In the operation of *brazing* the metals to be joined must be raised to the melting point of the brazing composition, which is soft brass. Although this makes the strongest joint, the necessity for exposing the articles to such a great heat renders this operation unsuitable for many purposes.

Soldering is very useful for joining copper and copper, copper and brass, copper and iron, brass and brass, brass and iron, tin and tin, and tin and any other metal. If the joint has to stand a rather high degree of heat—such, for instance, as the seams of a small steam boiler—a *hard* solder must be used. By this is meant a solder that only fuses at a high temperature; a *soft* solder, on the contrary, fuses at a low degree of heat.

The following are the compositions of some of the most useful solders, with the degree of heat required to melt each:—

	Lead.	Tin.	Bismuth.	Fluxing Point.
Plumbers' coarse solder . . .	2	1	—	440° F.
„ fine solder. . . .	1	1	—	370° F.
Tinners' solder	1	1½	—	334° F.
Bismuth, or pewterers' solder	1	1	2	203° F.

The surfaces to be united must be thoroughly cleaned and brightened—without this the metal will not adhere. The soldering iron must be warmed sufficiently to melt the solder; it must not be made red-hot, or the solder will be destroyed. Whilst the bit is warming, tin the surfaces by dipping them into melted solder, first coating the bright parts with hydrochloric acid, or spirit of salt as it is sometimes called. The acid must in nearly all cases be *killed* or rendered neutral, before it is used and this is done by putting into it small pieces of zinc and so making a saturated solution of chloride of zinc. Sometimes resin is used as a flux instead of the acid, but, except for lead, tin, or pewter work, the neutralized acid is preferable as it is much cleaner to work with. The process of "tinning" will cover the surfaces with a thin coat of solder. When it cannot be done thus, the surfaces must be tinned by means of the soldering bit. In this case they must be coated or washed with the flux as before, but the solder must be melted on the places required with the hot bit.

When tinned, the surfaces should be brought close together, a little flux rubbed along the joints, and the bit dipped in the flux and put against some solder, so that the melted solder will flow to it. The bit must now be applied to the joints, and drawn slowly along in such a manner that the metal between the joints is melted, and the joints filled up. A little practice will soon make the amateur skilful in doing this.

The soldering bit, or *copper-bit* as it is sometimes called, is a piece of copper riveted between the prongs of an iron rod which is fixed in a wooden handle. The copper, immediately it comes from the fire, and before it is used, should be rubbed against a piece of brick or something of that sort. This is done to remove any dirt or oxide that may happen to have got about it, and which, if allowed to remain, would prevent the solder from sticking to the copper—thus, in all probability, spoiling the operation. Besides the soldering iron or copper-bit, little else is wanted for soldering, an old knife for scraping clean the metal that is to be soldered, and a bottle containing a little muriatic acid or spirit of salt killed in the manner described.

Should it be desirable for the solder not to adhere to any portion of the article, a paste must be made with whiting and water, and put about those places; this paste will harden with the heat, but can easily be removed after the soldering operation is effected.

Very thin sheets of metal can be soldered best by moistening the surfaces with the flux and putting a piece of tinfoil between them, after which the two pieces to be joined are placed between a pair of hot tongs until the tinfoil is melted. This is a very simple, expeditious, and neat method of soldering thin sheets of metal.

In brazing, the pieces to be united are scraped perfectly clean, in the same manner as for soldering, and the edges painted with borax mixed with water to the consistency of paste. The pieces are bound firmly together with fine wire, or held together with a pair of tongs, and put into a clear fire. When just red-hot they must be taken out of the fire, and a few bits of spelter-solder and a little powdered borax put on the joint, which is then returned to the fire and kept there until the spelter is thoroughly melted.

If the operation is performed with care, the spelter will penetrate quite through the seam, and, indeed, almost through the pores of the iron itself. The spelter used for brazing should be tolerably soft and in small pieces. Braziers generally use granulated spelter, which is nothing more than melted brass dropped whilst liquid into water. When granulated brass is not at hand, brass filings will answer almost as well.

For brazing very small articles the amateur will find a blow-pipe and a piece of charcoal of great assistance to him. The charcoal is held an inch or two from a flame, which by means of the blow-pipe is caused to impinge upon the article laid upon the charcoal. A great heat is thus obtainable, the article is manipulated with greater facility, and the process can be watched much better than when a common fire is used. For larger articles a brazing-lamp, such as shown in Pl. XXX, Fig. 3, should be used.

The methods of soldering and brazing having been described, the various operations in working in sheet metals, plumbing, and gas-fitting will be more readily understood.

Working in Zinc.—We may confine ourselves in zinc-working to making such zinc joints as may be wanted in covering a roof, putting in the flashing of such a roof, and making a zinc gutter

and pipe; in plumbing to stopping a leak in a pipe and joining two pieces of pipe together; and in gas-fitting to one or two simple operations that the amateur can manage without assistance.

Zinc is sold in sheets 7 ft. and 8 ft. in length by 3 ft. and 2 ft. 8 in. wide. It is made of different gauges or thicknesses, each gauge being distinguished by the weight of the zinc to the foot super. Thus, the gauges most used and their weights are as follows :—

Nos.	10	11	12	13	14	15	16
Weight	9 oz.	11 oz.	13 oz.	16 oz.	19 oz.	22 oz.	25 oz.

For flats, gutters, and roofs, the best gauge is No. 15 or No. 16, on account of its weight, and therefore superior stoutness. In laying zinc, iron nails must be avoided, and the zinc must be kept from coming into contact with iron or lime, for when it does galvanic action is set up, which ultimately destroys the zinc.

The ordinary way of joining sheets of zinc on a roof, the sheets being disposed vertically, is by a joint technically known as the "roll" joint; but when sheets of zinc must be joined at the edges, as in forming the lining of boxes used for export purposes or the lining of a cistern, the edges must of necessity be soldered.

The *roll-joint*, which is used in joining sheets of lead or zinc, is made in the following manner. Just where the joint is to be made, a strip of wood about 1 in. or 1½ in. square is nailed, flat on the under surface and rounded above, a sheet of zinc is then laid on the roof, and its edge folded over the rounded wood. Another is then laid on, and its edge folded in the contrary direction over the edge of the first sheet. This last roll may be soldered down or kept in its place by a few tacks. The rounded form of the wood over which the zinc is bent effectually prevents the entrance of any water, even if the zinc edge is left unsoldered. Sometimes a triangular strip of wood is substituted for the rounded strip.

There is no absolute necessity for painting zinc work, for exposure to the atmosphere has the effect of coating it with a thin film of oxide, which protects it from the further action of the air as effectually as paint.

Flashings in Zinc Work.—To prevent the water from entering between the zinc and the boarding, or the coat of roofing felt which should be laid on the boards before the zinc is put on, pieces called *flashings* are inserted into the brickwork at the part where the zinc sheeting meets the wall. Taking as an example the zinc roof to a bay window, the upper edge of the

zinc sheets which cover the roof are first turned up over a flat strip of wood secured to the framework of the roof at its junction with the wall of the house. A piece of zinc is then cut with triangular flaps and fitted to the sloping sides of the roof of the window. The upper edges of the flaps are buried in the joints of the brick-work, the mortar being raked out to admit them. When the joints have been stopped with cement, the water that may trickle down the wall when it rains passes over the *flashing*, as it is called, the lower edge of which is turned over the strips of wood, and is received on the zinc sheeting whence it trickles down to the gutter. A long piece of flashing, runs along the top of the roof, and is turned down over the strip of wood on to the sheet of zinc forming the central portion of the roofing.

Gutters and Pipes in Zinc.—Gutters and pipes in zinc are formed by beating the zinc into the necessary form over a shape or mould of wood, and soldering up the edges of the pipes and the ends of the gutters to prevent the escape of the water that may run into the one or through the other. To make a short piece of zinc piping, the amateur can take an old broom handle as a mould, and having beaten a strip of zinc into the necessary form round this with a wooden mallet, he has only to solder up the overlapping edges and the pipe is made ; and if he wants a longer pipe he may connect two or three of these lengths by sockets of zinc just large enough to receive the ends of the pipes, soldering the whole together. To attach the pipe to a wall or boarding, a slip of zinc is soldered to the pipe itself or to the socket within which the ends of the two pieces of pipe meet. This strip on each side may be about 4 or 5 in. in length. A stout zinc nail is then hammered through the zinc in the part next to the pipe or socket, and the outer part is turned over to hide the head of the nail.

Gutters are made in the same way as pipes ; that is to say, the zinc must be bent and beaten into the required form upon a wooden mould. In order to give a more finished appearance and also more solidity to the work, the edges of the zinc should be doubled over inwards. The gutters are supported on brackets screwed to the facia below the roofing, whatever the material may be. Sometimes a short pipe or roll of zinc, is soldered within the gutter between the topmost parts or edges on either side, and transversely to the length of the gutter. Holes are made in the front edge

and back edge of the gutter to admit of the passage of a long and somewhat thin screw through the pipe. The screw enters the facia, and with others at intervals of about 2 ft. sustains the gutter. To carry off water from a gutter a vertical pipe must be inserted, and the shoot should have a gentle fall throughout its length, from one end to the other at which the vertical pipe is attached.

Tray of Zinc for lining Box.—The description of the method to be adopted in making a small rectangular tray of zinc, suitable for the lining of a wooden box, intended to stand on the sill of a window to hold flowers, will afford a key to the mode of doing all rectangular work in zinc, such as making the lining of a cistern, etc.

In describing the method to be followed in doing work of this kind, dimensions are of no importance, as it is only the mode of procedure that it is sought to show, and not how to make any particular box or tray of a certain size. The amateur can settle the dimensions according to his requirements. Having taken a sheet of zinc of the necessary length and breadth, allowance being made for the turning in of the edges all round the tray, mark the zinc by lines to show the bottom, the sides, and the laps to be turned in. Now cut out the corner pieces and turn over and beat down the edges. All the beating must be done with a wooden hammer or mallet. The sides of the tray round the bottom must next be turned up and beaten to the required inclination, which will be a right angle, over a rectangular block or bar of hard wood. When the edges of the sides have been brought into contact, solder them up. A wire ring may be soldered to the tray at each end, so that it may be readily lifted in and out of its wooden casing if necessary. A hole should be made in the tray at a convenient part, and a small waste pipe soldered to it to carry off the surplus water.

All working in sheet metal is done very much in this manner; the parts must be carefully cut out and fitted, and then soldered together. Accurate marking out of the different parts of which the article is composed is most essential, and to do this well a knowledge of drawing is necessary. There are other modes of working in sheet metal, as, for instance, in tin-plate, in which the article is formed by hammering up the material over a wooden block, pliers and punches of a simple character being required to form the edges and the indentations that are sometimes added by way of ornament.

No special directions are required for this kind of work. A shallow rounded tray or dish is formed by hammering a circular piece of tin-plate over a rounded block of wood of the pattern required.

Corrugated Iron.—Our notice of working in sheet metal, sufficient for the purposes of the amateur, though necessarily brief, would be incomplete without some mention of corrugated iron and zinc sheets for the purpose of covering the walls and roofs of buildings. Corrugated iron is generally *galvanized* or dipped in melted zinc, to keep it from rusting under the action of the air.

Corrugated iron and zinc can be fixed by the amateur without much difficulty. He must first put up a skeleton of wood to support the sheets, and on this skeleton or framework the sheets must be laid, being fastened to the framework and to each other. The sheets are fastened together by means of rivets passed through holes punched to receive them, and beaten down on small washers or flat rings of metal. The upper sheets should always lap over the sheets below after the manner of slates, tiles, weather-boarding, etc. They are joined vertically or at the sides by letting the outermost fold of one sheet lap over that of the sheet next to it. Corrugated iron is sold in sheets of various sizes, measuring from 6 ft. by 2 ft. to 8 ft. by 3 ft.

Plumbing and Gas Fitting.—A plumber's joint is used when two pieces of lead or compo pipe of equal diameter are to be joined together. The edges must be scraped clean, and a little tallow rubbed over them. The joint is then held in such a manner and gently turned so that melted solder may be poured all round it. The melted solder that adheres round the joint, is pressed on all sides with the plumber's wiping cloth, so as to smooth it down and render the surface perfectly even. The joint is thus made to swell round the junction of the pieces of pipe on all sides in an egg-shaped form. When there is no side-strain on the joint, as in a pipe running down the side of a wall, the joint may be made in the manner shown in Pl. XXIX. The end of the lower piece is slightly enlarged by knocking a small cone of boxwood, known as a turn-pin, into it (as shown in Fig. 2) while the edge of the upper piece is scraped away a little, with a shave-hook, so that it may fit into the piece below (Fig 1). The upper part of the pipe is then dropped into its place, the solder run into the space, and the joint made by means of the small blow lamp as shown in the illustration (Fig. 3) or by passing the heated iron round the ring of solder.

When plumbers' fine solder is used, the flux should be a mixture of tallow and resin.

In gas-fitting, if the pipes be of iron they are put together by screwing the ends of the pipes into a socket. With connections of this kind, specially made for the purpose, pipes may be joined together at right angles, or three pipes may be brought together by means of a T-joint, by which two of the pipes are joined in the same straight line; the third proceeding from the point of junction at right angles to the other two. The male screw of every pipe that enters a socket should be smeared with white lead before it is put in. Gas-burners should also be treated in this way. The white lead renders the joint impervious to water, air, and gas.

Small pipes of "compo" metal used in gas-fitting, are joined in the following manner. A small copper bit is used for small gas-piping, and a softer kind of solder, as the composite metal melts at a comparatively low temperature. These compo pipes may be soldered to taps and connexions of all kinds in the same manner. The joint made in gas-fitting need not be so large as the ordinary plumber's joint on a water pipe; indeed, but little solder is required in making a joint in gas-piping.

A joint cannot be made unless the piping is perfectly dry. Therefore, before attempting any repairs to lead water-pipe, the water supply should be turned off at a tap usually placed within the house just at the spot where the service pipe enters; for gas pipes the gas should be turned off at the meter. The pipes must be allowed to dry. This can be assisted by a little heat near the spot it is desired to solder. When a pipe is cracked by frost or otherwise injured, it is useless to attempt to stop the slit or hole until the pipe is dry. As soon as this is the case, the crack or hole may be filled up with solder, or, what is far better, the pipe may be cut, the broken part removed, a piece of sound pipe substituted, and the ends joined together again.

The fixing of the gas burners will rarely present any difficulty. In selecting the position for a bracket, care should be taken that it is quite out of reach of curtains, cupboard doors and other movable articles. The supply pipe leading from the bracket should be taken as directly as possible to the main supply, which may be in the ceiling above the room, or under the floor beneath, or in the wall of an adjoining room. In order to hide from view the pipe which is being fixed, it may be carried behind the skirting boards, or in angles of the wall where it can be papered over. One end of the pipe having been soldered in the manner

described above to an "elbow nose piece," which is a piece of ⅜ in. brass tube bent at right angles and fitted with a screw thread at one end, a round mahogany block is slipped over the threaded end of the nose piece and nailed or screwed to the wall. The projecting end of the nose piece is then smeared with white lead and the bracket screwed on so that the flange is tight against the wood block to which it is to be screwed. When the bracket is thus fixed all that remains to be done is to lead the pipe away to the main supply and join it on by means of a suitable union.

All modern gas fittings which the amateur may require, such as plugs for stopping the ends of pipes, sockets, T-pieces, elbows, and bends, can be obtained of standard dimensions from the ironmonger. The only tools required are a good pair of gas pliers for screwing the joints tight and one of the small combination gas-burner taps occasionally necessary for easing the screw-threads. Iron piping should be bought, cut to length and with the ends screw-threaded as required.

Iron Cement.—A very strong and durable cement for uniting iron may be made from the oxide of iron itself. This "rust" cement, as it is sometimes called, will be found useful for caulking the joints of iron pipes, tanks, etc. It is composed of fine cast-iron turnings, powdered sal-ammoniac and flour sulphur. The ingredients are mixed together and damped, when they soon begin to heat. They are then again mixed and covered with water.

The following proportions are those usually recommended :—

Quick-setting Cement.—80 parts by weight iron borings ; 1 part powdered sal-ammoniac ; 2 parts flour sulphur.

Slow-setting Cement.—200 parts iron borings ; 2 parts sal-ammoniac ; 1 part flour sulphur.

The slow-setting cement is the better if the joint is not required for immediate use. The joint can be used under water. The parts thus joined can only be separated with difficulty, but this can generally be done by heating them to redness and jarring them with the hammer. The application of a little paraffin to the joint will be of assistance.

Soldering Repairs.—There are many domestic utensils that may easily be repaired by soldering.

Supposing that the damaged article is a coffee-pot, and that the damage done to it consists in the spout having become unsoldered by getting in a flame when placed on the fire, the edges of the separated parts must be scraped clean, and dressed with soldering

flux (chloride of zinc). The parts to be united are then held close together, and some solder run round the joint by applying the end of a stick of solder to the hot point of the copper bit, the heat of which will melt the solder and cause it to flow nicely round the joint. The method in which a leak in a watering-pot may be similarly repaired is illustrated in Pl. XXX, Figs. 1 and 2.

Suppose that the article to be mended is a leaky pan. If the leak cannot be easily detected with the eye when looking over the article, some water must be placed in it, and the places at which the water issues must be carefully marked. In any case, the black crust which has gathered on the pan, must be carefully scraped off, so as to render the pan as bright and clean as may be in this particular part. If there be but one or two small holes, the pan may be made useful again by spreading a drop of molten solder over and round the hole or holes. This will be sufficient to mend small pin holes; if, however, the holes be too large to be stopped with a little solder, and they occur in three or four places near to one another, the best thing to be done is to lay a new piece of metal of sufficient size to cover all the holes, and reach a little beyond them. The piece may be cut of the shape required from any old tin. The cutting is easily effected by a pair of shears or strong scissors, kept for this purpose. After marking the place where the patch is to be put on, scrape the metal perfectly clean to the extent of $\frac{1}{4}$ or $\frac{3}{8}$ of an inch on each side of the mark. Now clean the soldering bit, which has been heated in the fire, dip it for an instant in the soldering flux and bring the solder in contact with it, when the solder will melt and cover the end of the copper bit, making it as bright in appearance as tin plate. Replace the bit in the fire so that it may be kept hot for use when wanted, and then lay the new piece of tin on the pan in the position in which it is to be fixed, and which has been sufficiently indicated by the mark made by the cleaned patch. The pan may be touched with flux along the line where the joint is to be made and the new piece as well. A little of the solder may now be melted along the joint by means of the bit, and the solder should be drawn along the edges until the joint is complete and perfect in every part. When the solder has cooled, which it will do very quickly, the vessel may be filled with water to see if the work has been properly and effectually done.

Bell-hanging.—In bell-hanging no soldering is required, but in wire-working soldering will be sometimes found useful in

uniting the ends of a piece of wire so as to form a ring. A neater joint is made in this way by filing down the wire and fitting the surfaces together for the length of an inch or two, than by twisting them together or by the usual plan of forming a loop at each end of the wire, thus hooking the ends together.

In the old style of bell-hanging the tools required beyond what the amateur may already have in the shape of hammers and chisels for lifting floor-boards and removing skirting-boards, and a screw-driver for fixing these in their places again by means of screws, are pliers for bending, twisting, and cutting the wire, and one or two gimlets with shanks two or three feet long known as "bell-hanger's gimlets" for boring a passage for the wire from one floor to another. This is only required in old houses, or in new houses in putting up bell furniture in rooms where no provision has been made for bell-hanging. It is usual in building a house in the present day to provide for the passage of the bell wires from floor to floor by inserting bell-tubing in the walls. This tubing is buried in the plaster, and the wire can be passed down it at pleasure without doing any injury to the walls. Even in an old house, when undergoing thorough repair, it is advisable to insert bell-tubing by cutting a channel for it in the plaster, if the walls be plastered, and filling up the depression and hiding the bell-tubing with some fresh plaster. The old-fashioned style of bell-hanging is perhaps the most expensive work done in the house when viewed in relation to the materials and fittings used. Much trouble, care, and consideration is involved, so that the bell may work easily. To this end the position of the bell, the handle by which it is set in motion, and the course taken by the wire should be duly considered, the course of the wire being arranged so as to avoid angles wherever it is possible to do so ; because wherever the direction of the wire is changed a crank is necessary, and every additional crank increases the difficulties.

The kinds of cranks to be used and the direction to be taken depend entirely upon the position of the room in which is the bell pull with regard to the board on which the bells are hung. This board is generally fixed in the kitchen or in the passage without and near the kitchen door.

In the simple case in which the bell pull is in a sitting-room and moves a bell fixed over the kitchen fireplace in the kitchen below, the wall of the sitting-room is merely a continuation upwards of the wall of the kitchen, and the wires by which the bell is moved lie all in one plane. There are, indeed, but two

pieces of wire required, and these are at right angles to one another. The bell-pull or handle by which the bell is set in motion is attached to a circular plate, with a rim part way round it. Fastened to the lever or to the rim of the plate is a flat chain, which, when the lever is pulled down, is brought upwards and backwards on the rim of the plate. The end of the chain passes into the tubing in the wall, and to it is attached the wire. The lever can be moved downwards until it meets the flange or rim which checks its further progress; the other end of this flange prevents it from doing more than return to its original upright position when released.

The wire passes down the tubing and out through the ceiling of the kitchen, and here it is necessary to change its direction from a vertical to a horizontal course. To do this a crank is necessary. This is a triangular piece of brass, having a hole at each angle. The crank is shown at Pl. XIX, Fig. 2. It works on a pin or pivot inserted in the wall or a piece of brass fixed to the wall. The other end of the wire, fastened to the chain, is passed through the hole in the crank. The wire should be strained tight when put up, but the bell should be allowed to hang perpendicularly. When the handle is pulled, the wire is pulled in an upward direction, and the corner of the crank is raised.

The bell itself is attached to a T-plate of brass, fastened by nails to the wall or by screws to the wooden bell board. To the T- plate a lever or arm is attached, working on a pivot; and to the upper end of the lever, opposite to the pivot, is fastened one end of the wire, the other end of which is attached to the corner of the crank. To this end of the lever is also fastened one end of a coiled wire spring, the other end of which is secured to the wall and the effect of which is to sharply bring back the lever to its original position after the bell has been pulled. Round the pivot passes the loop of a flat coiled spring to which the bell is attached, whose action keeps the bell in motion for a short time after the bell-pull has been released. When the handle is pulled the first wire is pulled upwards, bringing up the end or corner of the crank. The upward motion of the crank, working round the pivot jerks the lever arm at the other end of this second wire, and the bell, being set in motion, sounds. By the tension on the wire the spring which is fastened to the wall is pulled out. As soon as the handle is released and this tension is removed, the spring recoils and brings back the lever to its former position. As long as the bell is in a

working condition, the handle of the bell-pull will remain upright; but if any of the wires get broken, or slackened to a great extent, the handle inclines from its upright position, showing that the bell is out of repair and ought to be seen to. If it is only through the slackening of a wire, the end of the slackened wire may be untwisted with the pliers, drawn a little farther through the loop of the crank, and then twisted up again. Bell wire should always be stretched before it is used. To do this, one end should be securely fastened, and the wire pulled gently with a pair of pliers. Wires of gauges 16, 17 and 18 are most generally used for house bells, and Nos. 14 and 15 for out-door purposes.

The practice of fitting electric bells has now become so general that the old style bells are rarely found in newly built houses.

Electric Bells.—Electric bells work quite differently from those actuated by cranks and levers. The wire carrying the electric current is not subject to any movement and may be fastened firmly to a wall and twisted in any direction. It is unnecessary in the present work to discuss the principles that govern the action of the electric current. For the practical purpose of the amateur it is sufficient to know that the electro motive force always called the E.M.F., is generated by chemical action in a primary battery cell. For the ringing of bells these battery cells are usually wholly self-contained. Dry cells are now very often used; these are obtainable at most ironmongers and at all dealers in electrical sundries. The wet cell in common use for bell-ringing, called the Leclanché, has for its negative element a carbon rod in a porous pot, and for its positive element a zinc rod in a square glass outer jar, which may be of one, two or three pint capacity. The porous pot is filled around the carbon rod with crushed coke and peroxide of manganese, and the top is sealed with melted pitch or similar material, a small hole being made through this material so as to allow of the escape of gas generated in working. The zinc rod always requires to be amalgamated before use. Amalgamation consists in coating the entire surface of the zinc with mercury. Both the positive and the negative poles have attached to them a brass terminal fitted with a screw to facilitate their connection with the bell wire.

When the cell is wanted for use, the porous pot is placed in the middle and the zinc rod is placed in one corner of the glass jar, which is then three-quarters filled with a saturated solution of sal-ammoniac. The cell will be in working order as soon as

the solution has permeated the porous pot, and this may be hastened by pouring some of the solution through the small gas-hole in the top of the porous pot.

The various dry cells now obtainable at small cost are modifications of the wet cell just described, but they possess many advantages over it; amongst these are cheapness and entire absence of mess. When more than one cell is used, the combined cells constitute a battery and, roughly speaking, the greater the length of wire through which the current has to travel and the greater the frequency of the ringing, the more cells will be required. In forming a battery the poles of the cells are coupled by copper wires. When arranged "in parallel" all the positive elements are connected together and all the negatives together, so that the elements of the small cells are combined into the equivalent of one large cell. This gives a current of high amperage and low voltage, or in other words greater volume of current. If, on the other hand, the poles of the several cells are connected "in series"—that is, the zinc of one cell to the carbon of the adjoining cell—a current of high voltage and low amperage is produced and in this way the resistance of a long circuit of wire may be overcome. To make this clear, the former method may be compared to a shallow water tank with a large hole near the bottom from which the water would issue at low pressure and the latter method to a high tank with a much smaller hole, from which the water, being under greater pressure, would squirt out in a small jet.

The battery or battery cell is active only during the time that the circuit is closed—that is, whilst the bell is ringing—and therefore the lasting quality or life will depend on the frequency of its use. In some houses the electric bell may be rung on an average only twenty or thirty times in a week, whilst in others there may be as many rings in half an hour. This must be taken into consideration when deciding on the number of cells; one or two quart-size cells suffice for a small number of pushes used but seldom, whilst a dozen or more cells may be necessary in a large installation frequently used. During the time a Leclanché cell is in actual use hydrogen is evolved and this unites with the oxygen given off by the manganese; the hydrogen is generated much faster than the oxygen and the excess is absorbed by the carbon. This has the effect of polarizing the cell, and the current becomes less and less until it is insufficient to overcome the resistance, and so ceases to ring the bell. Whilst the cell is not in use, this condition will right itself and current will become available for

another ringing of the bell. Thus the current from a Leclanché cell is not constant, being soon exhausted, but recovers itself when used intermittingly. From what has been said, it will be clear that larger batteries—that is, more cells coupled " in parallel"—must be used when current is wanted frequently than would be the case when a current is wanted seldom.

Apart from the action just described, ammonia vapour is generated when a cell is in actual use, and this vapour corrodes the connexion of the cells and also any other metal which is within its reach. When the action is severe the connexions are often badly damaged and even spoilt. Cells should be kept in a cool, dry place, out of the way and out of sight, but readily accessible, so that they may be looked at from time to time. In ordinary cases, cleaning and renewal of evaporated fluid may be done about once a year, but, when the batteries are called into action very frequently, an interval of a month or so may be long enough.

The current produced in the battery is conducted in a continuous circuit from pole to pole by the copper wire. The line wire used for electric bells is also made of copper, this metal possessing a high electrical conductivity. Twin wires, which are perfectly insulated by being coated with cotton saturated with melted paraffin wax, are now always used, the two wires being generally bound together by another layer of insulated cotton. This line wire may be bought ready for use of all dealers in electrical apparatus. A better insulation is provided by covering either one or both wires with rubber or one of the many compounds used for the purpose. For good class work and in places likely to be damp this kind of insulation should be preferred. The double cotton-covered wire may do for cheap work and for temporary fittings. The sizes of line wire generally used for electrical bell work are Nos. 18, 20 and 22, and the middle gauge may safely be chosen. For some purposes a flexible wire is required: this is made by using a bundle of from 6 to 12 fine copper wires which together provide a conductor equal in area of section to the single wire. These cords are as flexible as a piece of string; they are made with wire of Nos. 36, 38 and 40 gauge, six, nine and twelve strands being used. These are described as 6/36, 9/38, and 12/40, the first figure denoting the number of strands and the second the gauge of wire. The various kinds of wire may be bought, either by weight or by length, and when wire is wanted only sufficient for a particular purpose the distance that it has to run should be measured and the required length obtained.

The pushes, bells, indicators, etc. that are required in fitting up

an installation of electric bells are to be bought in an endless variety of style, quality and price, and at a cost that is considerably less than would be that of making them in small quantities. We may therefore assume that the amateur would procure, when the installation is to be commenced, all the necessary fittings, together with a sufficient quantity of wire. On this assumption, the first step will be to go through the whole bell-wiring system that it is proposed to carry out and to make a note of every item required. Most dealers in electric bell fittings publish illustrated price lists, and some of these lists should be at hand for reference when making choice. The position of the indicator is perhaps the best thing to decide first; this should be where it will be most conveniently seen by the person who has to answer the calls, and the bell should be so placed that it may be heard at all points necessary and the battery should be near it. These positions will of course depend upon the size and the design of the house and must be left to be determined by the people on the spot. We may suppose that the notes to be taken of the items required begin with the front door. Here we shall note that an outside door push is wanted; the position of the push must be determined and one suited to the purpose may be chosen from a catalogue. Making a mental note of which way the wire will be got through to the inside of the door we may proceed to trace the course that the line wire will take to reach the indicator and can then measure the distance and make a note of the quantity of wire that will be required. The course of the wire will differ with every variety of house, and beyond recommending the amateur to keep as much as possible to long straight runs of wire, concealed by cornices, skirting boards or dado rails, the planning must, as already stated, depend upon circumstances. Next begin at some other point where a bell-push is required—say in the dining-room, near the fireplace. Here the brick-work of the chimney breast will require to be plugged to afford screw holes for fixing the bell-push. The desired style and make of the push may be selected from a catalogue. From this push the wire will be taken to the indicator by the most convenient course. In new houses and in high-class work a zinc tube, extending from the bell-push to the skirting-board, would be embedded in the plaster of the wall, and the line wire would go through this tube and so be quite hidden from view. When fitting electric bell wires in old houses, where their appearance is not a matter of great importance, it is quite allowable to fix the wire on the surface of the wall. This may be often done in a way that leaves the

line wire invisible to casual inspection. The bell-push is placed close against some sheltering angle and the wire that leads from it is selected of a colour to match the decorations against which it is to be nailed.

When more than one bell-push is to be used in the same room, all the wires from the several pushes are brought together at some convenient place and connected, so that they are continued as one wire to the indicator. The indicator shows from which room the bell has been rung. The quantity and the colour of the wire that will be required in each room is thus noted and in the manner described the position and kind of the bell-push to be used is determined and the course of the line wire is thought out. When all the pushes have been located the number of places from which bells may be rung will be known, and an indicator having the requisite number of holes may be added to the list of fittings to be obtained.

There are three ordinary varieties of indicator, all of which are operated by an electro-magnet which releases the signal vane; one has to be replaced by hand after use, another is replaced by the electric current, and yet another consists of a simple pendulum, which is set in motion when the circuit is completed and which swings for a minute or two and gradually comes to rest. The first-mentioned kind is that generally used; in this the indicator is set with all holes blank by pressing a sliding rod; then when a circuit from a bell-push is completed the vane is released and shows at the particular hole to which it belongs. Before this vane can be used again it must be replaced by pressing the sliding rod. The second kind is replaced by sending a second current through the wire, but it is not so satisfactory in its results. The third kind is very simple and needs no replacement, but it is likely to cause confusion if instant attention is not given to the call before the particular pendulum may have almost ceased to vibrate. For general purposes the mechanical replacement indicator may therefore be recommended.

The electric bell is used only to call attention to the indicator and only one bell is required, irrespective of the number of bell-pushes. A bell of fairly good quality will last for many years if fixed where damp will not affect it. The ringing of the bell should be tested at the shop where it is bought. There are many varieties of pattern and tone from which to make a choice. As a matter of general convenience the bell is usually fixed at a point near the indicator, but this is not at all essential.

Having procured all the fittings and materials that are shown

by our notes to be required for the particular installation, we may proceed to the work of fixing the bell-pushes, wires, indicator, bell, etc. Every push, indicator, bell and battery has a conveniently arranged clamping screw by which connexion can be made to the circuit wire. These clamping screws are provided with milled heads to be actuated by thumb and finger in all places where the connexions have to be made and broken frequently or even occasionally. In cases where the connexions are permanent the screws have a slotted head to be turned with a turn-screw. If the line wires are sufficiently long to reach from point to point and are handled carefully, so as not to break them, it will be possible to complete the entire wiring without having to solder a joint. This is commonly the practice in small installations.

When the wires from more than one bell-push have to be connected and so form one line wire to the indicator, the connexions must be properly soldered, or they will soon become defective. The copper wire must be laid bare by scraping off the insulating covering and the bright wires twisted together for a length of at least half an inch and soldered by means of a copper bit. The flux to be used must be a non-corrosive one; resin will suit very well, or one of the many tinning preparations specially compounded for the purpose may be used. The soldered joint should be carefully and thoroughly covered with insulating material, rubber tape being that generally used.

Commencing with the front door push we may first decide its exact position on the door frame and then with a gimlet bore a hole through the wood to allow the line wire to pass. Some note should be taken as to the most desirable point inside the door frame for the exit of the gimlet. Often a straight through hole is not the most desirable one to make. In any case the hole should be just large enough to allow the twin wire to pass; big holes are unsightly. The wood around the bell-push will need some trimming to allow the push to bed down properly. This trimming may be done with a gouge or chisel or even a pocket knife serves the purpose in many cases. The bell-push is fixed in its place usually with a couple or three ordinary wood screws. Before the final fixing, but after the fitting has been completed the line wire must be connected to the push. Supposing the wire to be in a coil, the outer end is straightened for a length of a foot or two and passed through the hole in the door frame. A convenient length is drawn outside and the twin wires are separated for an inch or so. One brightened end is fixed under one of

the clamping screws of the bell-push, the other brightened end under the other clamping screw. The clamping must be done thoroughly well, first taking a half turn of wire under the screw head, and the two bared wires must on no account be in contact with each other or with the same piece of metal on the bell-push. Perfectly solid contact should be made at the two clamping screws and beyond that the wires should be kept well apart to avoid short circuiting. Before fixing anything, the efficiency of the work may be tested by baring the other ends of the line wire in the inner part of the coil and connecting these with the electric bell terminals, the battery being interposed, of course. Then on pressing the push, if all is in proper order, the bell will ring. The bell-push may then be finally fixed.

The line wire is carefully uncoiled at its outer edge for a convenient length and placed in a position leading to the point where the indicator will be fixed. At suitable intervals, which may range from a foot to a yard, the line wire is fixed to its support—the skirting cornice or whatever it may be—by wire staples specially made for the purpose: a sufficient quantity of these staples should be procured when buying the fittings. It is easy to spoil the whole work when driving in these staples. The insulating covering of the line wire must not be damaged, nor must the staples be driven in so far as to break the covering, and so cause short-circuiting by connecting the twin wires. The wire may be run in any direction and bent at any angle without affecting its efficiency unless the bends are made so carelessly as to break the wire or destroy the insulators.

When the line wire reaches the indicator one of the twin wires is connected to the appropriate screw of the indicator, the other wire is connected to one terminal screw of the bell. The other terminal screw of the bell is connected by a single wire to one pole of the battery and the other pole of the battery is connected to the indicator. This completes the whole circuit so far as the one front door bell-push is concerned. Here it may be convenient to trace the course of the electric current and its action through this one-bell system. First let it be understood that the electric current is supposed to flow along the line wire in one direction continuously so long as the wire is unbroken, and when the continuity of the wire is broken the current ceases. In the present case the break in the circuit occurs in the bell-push at the front door. On pressing the push the current proceeds, say, from the button to the contact piece below it, thence through the clamp screw, along one twin line wire to one terminal screw of the indi-

cator, through the coil in the indicator to the other terminal screw, along the single wire to one terminal of the battery, through the battery to the other terminal, along the single wire to one terminal of the electric bell, through the coil of the bell to the other terminal and thence along the other twin line wire back to the push on the front door, thus completing the circuit. On removing the pressure from the bell-push the spring separates it from the contact piece below, and the circuit being thus broken the electric current ceases to flow. Although the electric current is actually generated in the battery, this is immaterial for purposes of explanation. The wire is always charged with the current and ready to carry it onward as soon as the circuit is completed. This explains the completion of one electric bell circuit, and any number that may be added will only be repetitions of the same, it being understood that one bell and one battery will serve for all the circuits. The bell-push, the line wire and the connexion of this with the bell and indicator are necessary in each case, but the same connexion between the bell, the battery and the indicator will serve for all.

Telephones.—Telephones for domestic use and for communicating between house and stable, office and factory, etc., are easy to fit up and a great convenience in use. When once a domestic telephone system has been installed and got into satisfactory working order it is soon classed among those things that are indispensable. In this book we are not concerned with the apparatus used by the telephone companies, by means of which subscribers are linked together on speaking terms even when hundreds of miles intervene; these telephones are much more complicated than the domestic appliance which is dealt with here. There are many varieties of domestic telephone apparatus obtainable of all dealers in electrical sundries at extremely low prices. Each apparatus consists essentially of a transmitter and a receiver; the two are often combined in one appliance. A pair of these appliances, one at each end of a suitable line wire, No. 20 gauge being the usual size, constitute the simple form of telephone that will serve the practical requirements of a compact establishment where the line wires do not extend beyond a few hundred yards. The ordinary electric bell line wire serves all practical purposes as a telephone line wire, and this without interfering with the ordinary use of the bells. If precaution is taken when installing the electric bell to fix a bell-push with a suitable attachment for the telephone, then we shall have all that is necessary for connecting the two telephone appliances.

The ordinary existing bell wires will also serve every purpose, but some alteration is necessary to provide suitable connexions. Many of the ordinary electric bell-pushes are made with the additional pin-and-socket connexions for attaching an extra length of flexible wire so that a pear push may be used at the bed-side or elsewhere, and these pin-and-socket connexions are just what are wanted for the telephone connexions. These pushes have a pair of sockets, one attached to each of the clamping screws; these sockets receive a double pin coupling from which the flexible wire is extended to reach as far as may be desired. The making of telephones suited for the uses here described cannot be undertaken with advantage by the amateur; the component parts, bought singly, would cost more than the complete instruments ready for use. The instructions on wiring for electric bells give all information necessary for fitting up the wiring for a domestic telephone installation.

Electric Lighting.—Electric lighting has become so general that some reference to the subject may well be expected here. The electric energy or current for lighting purposes is generated at the central stations of the various electric supply companies and is conveyed by mains laid in the public thoroughfares. In these respects the procedure resembles the more familiar practice of gas supply for illuminating purposes. Dealing here only with the lighting system as used for small installations for private houses, shops, etc., the currents supplied at the main may be either "alternating" or "continuous," and the voltage either "high" or "low" Before arranging the fittings it is necessary to know which system of supply will be available, and this is always clearly stated on the circulars issued by the electric companies. An alternating current is constant, but continually changing forwards and backwards, it may be one hundred times per second, while the continuous current flows in the same direction always. The terms high and low applied to the voltage or pressure of current do not define precisely any given pressure, but low voltage is usually understood to mean 100 to 110 volts, and high voltage from 200 to 220 volts. This voltage or pressure of the main supply is not standardized and varies in different localities. In the Board of Trade regulations, not exceeding 250 volts is a low pressure supply; not exceeding 650 volts a medium pressure supply; not exceeding 3,000 volts is a high pressure supply and exceeding 3,000 volts is an extra high pressure supply.

The difficulties and dangers attending the use of the current for electric lighting unless proper precautions are taken are serious. The Board of Trade have made regulations that must be complied with in all cases, and insurance companies have also something to say about the placing of live wires carrying electric current. These rules are made in the interest of public safety, and do not imply that there is any great danger in the employment of electric current, but only that efficient safeguard must be provided when the voltage is high. For these reasons it would be unwise for an inexperienced amateur to attempt to lay the wires for electric lighting, except under the immediate supervision of an expert. With reference to the supply of current for incandescent electric lamps, the Board of Trade rules say :—The consumer's wires forming the connexions to the incandescent lamp, or otherwise in connexion with the supply, shall be completely enclosed in strong metal casing, and this casing, together with the switches and lampholders, if metallic, shall be efficiently connected with earth. Switches, efficient fuses, or other automatic cut-outs shall be provided so as to prevent the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fires being caused by their normal or abnormal action.

As a set-off against the somewhat disquieting suggestions contained in the preceding paragraphs it may here be said that the electric-light forms the safest of all illuminants when the installation is carried out with thorough efficiency. The best practical proof of this is shown by the terms quoted by the fire insurance companies. There are many highly desirable qualities in electric light that commend it above all others ; amongst these are cleanliness in use, purity of light, coolness and convenience. There are other domestic uses to which the electric current may be put, such as heating and power, and the advantages of these applications are set out in ample detail and perhaps sometimes prejudiced fervour by the companies supplying current. The reader who wishes to know more of the practical application of electricity should apply to the company in his district and he will readily obtain the latest and fullest details of what is available.

Wire-working.—Some knowledge of wire-working will be useful to the amateur, for with a file, a gimlet and bradawl, and a pair of pliers there are many useful bits of work that can be done

for the house and garden. For example, hanging-baskets for greenhouses, conservatories, and windows in which plants are kept, can be easily made ; wire trellis for walls, supports flat and circular for flowers—such as fuchsias, and sweet-peas—and sieves for sifting mould and ashes.

Wire is made in all sizes, of copper, iron, and brass. When the diameter is larger than about $\frac{1}{4}$ in. it can no longer be considered as wire, but is spoken of as a rod, whatever may be the metal of which it is made. The stoutest wire that the amateur will be likely to use will be about $\frac{1}{8}$ in. in thickness, and this will be chiefly used for imparting strength and solidity to wire-work, as will be seen presently. The amateur will also want wire of various smaller gauges, from $\frac{1}{16}$ in. to $\frac{1}{32}$ in. in diameter, and fine binding wire for securing wires that cross each other at any angle. The kind of wire most suitable for binding is fine copper or soft iron, because these are pliable, and therefore can be more easily bound round the wires that they are used to fasten together. For purposes where strength is not so much an object, the hard drawn tinned iron wire used for decorative purposes, such as binding evergreens to a rope to make a garland, is serviceable.

Galvanised iron wire will be found useful for making fences, especially to separate a lawn or garden ground from pasture land for cattle.

To fix fencing of this kind, stout posts are required at either end, with spurs or struts to enable them to withstand the strain of the wires. The intermediate posts may be slighter in size. The straining post, sawn out of fir or oak, should have the wood left on at the bottom to give it a better holding in the ground. When the wires are tightened the strain of the upper wires will have a tendency to drag the tops of the posts towards each other. To resist this, a strut is placed in position at an angle of 35°, one end of which butts against the straining post, while the other rests on a stout board of timber crossing it at right angles like the top of a T. The pressure of the strut against the board, caused by the strain of the wires, is distributed all over the surface of the board instead of being concentrated at the spot where the strut rests on it and is met by the resistance of the earth. The wires are tightened by means of bolts, with a loop at one end, and a nut and screw at the other. When the bolt has been inserted in its place in the post and the nut fitted on to the end, the wire is drawn as tightly as possible through the loop, and secured by twisting up the projecting end. The nut is then screwed further on the bolt, which is gradually brought

forward, thus tightening the wire. The wires may be passed through holes made in the lighter intermediate post to receive them or pinned down to the exterior of the post with a staple. Straining bolts may be used at each end of the wire, but if the fencing be short, one set of bolts will be sufficient, the other end of the wire being passed through the post and looped, a stout nail or piece of iron rod being passed through the loop to prevent its withdrawal.

Galvanised Netting.—Wire is now extensively used for horticultural purposes, and wire netting is useful for making poultry houses. Cats do not climb over wire netting; but whenever it is used for this purpose, care should be taken to have it high enough to prevent them from jumping over. The usual widths of the galvanised netting kept in stock are 12 in., 18 in., 24 in., 30 in., 36 in., and 48 in. A 2 in. mesh 72 in. wide is also obtainable. This will be found very convenient for poultry yards.

Garden-sieve.—For the garden sieve a square or rectangular form will be found most convenient to the amateur. A square frame must first be made. This should be of $\frac{3}{4}$ in. stuff, nicely planed down and dovetailed; or, if merely nailed together, secured by iron plates bent at right angles similar to those used to strengthen common wooden boxes. The frame being made, pass three stout wires from $\frac{1}{8}$ in. to $\frac{3}{16}$ in. in diameter through it from side to side, at distances of about 3 in. apart, and then pass smaller, but yet strong and stout, wires from end to end, and within the larger wires. The distances between these wires may vary from $\frac{1}{4}$ in. to $\frac{1}{2}$ in., according to the nature of the stuff to be sifted. The ends of the thick wires need not project beyond the outside of the frame, as there will be some difficulty in turning the ends and beating them down; but the ends of the thinner wires should project about $\frac{1}{2}$ in., and be turned and beaten down on or even into the wood. The thin wires should then be attached to, or bound down on, the thicker transverse wires with a piece of copper wire. The binding is effected by passing the copper wire once over each thin wire to bring it down to the thick wire. When the ends have been beaten down they may be concealed and a neat appearance imparted to the sieve by nailing a ledge all round the bottom, and for convenience in holding the sieve when in use, cleats may be nailed along the sides. The cleats should only be on two opposite sides, and these should be the sides through which the thick wires pass.

Circular Pea-trellis.—For the circular pea-trellis, which is made entirely of wire, a different mode of procedure must be adopted. First of all, two pieces of thin board must be taken, and circles marked on them. Holes at equal distances from each other must be made in the circle marks; and larger at distances of about 6 in. for the reception of stouter wires, and smaller at all the intervening holes to take the thinner wires. When the holes have been made the wires should be passed through the boards, the thicker wires being cut longer than the thinner ones, that they may be thrust into the ground. Before the ends of the wires are passed through the boards three or four hoops of wire, made a mere trifle larger than the circles on the boards, should be passed over and outside the wires. These hoops must be placed one just below the upper board, one just above the lower board, and the rest at equal distances up and down the wires. These horizontal wires must then be bound to the perpendicular wires with binding wire, after which the boards must be removed by gentle pressure. After this an ornamental appearance may be given to the trellis by turning the tops of all the wires outwards. This is easily done with a pair of pliers.

Wire Trellis.—In making a trellis of strong wire for the green-house or conservatory for climbing plants, a strong wire frame, must first be made, and it will be convenient to keep this in its place by pinning it down to a flat surface, but not so tightly that it cannot be raised for about ¼ in. from the surface to which it has been fastened down. The frame or the boarding on which it is laid must then be spaced out so as to bring the wires that form the trellis work at equal distances from one another; and the wires, so as to impart firmness to the trellis, must be interlaced under and over each other alternately, and their ends turned in a loop over the frame and beaten down. When every wire has been put in its place the trellis is complete, and the pins or staples that hold the frame down may be removed. It is almost unnecessary to say that the frame must be made precisely the size of the space that the trellis is intended to cover.

Hanging Baskets.—With regard to hanging-baskets for conservatories, etc., the mode of operation is somewhat similar to that described above for making a circular trellis for plants requiring support. The shape of the basket having been decided upon, some circles of the requisite size must be made to serve as foundations for the work, to which transverse pieces must be bound forming the bottom and sides of the basket Three or four long

pieces of wire, one end of each of which is linked on to the topmost circular wire of the basket, and the other attached to a ring or other contrivance, must then be added to provide for the suspension of the basket. The ingenuity of the amateur will suggest many other ways of forming flat and circular trellis work for plants in pots.

CHAPTER X

PAINTING, GRAINING, STENCILLING, STAINING, VARNISHING AND GILDING

THE subject matter of this chapter may be devoted to a consideration of the following subjects: (*a*) how to make or mix paint; (*b*) the brushes and tools used by painters in applying paint to the surface to be painted; (*c*) graining and the higher branches of house painting; (*d*) the art of stencilling, and how it is managed; (*e*) the method of imitating various woods, and improving the appearance of woods used in house building; (*f*) varnishes, their composition and the various purposes for which the different kinds may be used; and, lastly, the modern appliances and preparations used in gilding. In each of these branches of the painter's trade only such points will be touched on as are likely to prove useful to the amateur.

Ready Mixed Paint.—For the general purposes of an amateur it is much better and cheaper to buy paints and varnishes ready mixed, but for the benefit of those who desire to mix their own colours it may be useful to give a few directions which will enable them to do so. The oil and colourmen supply at a very moderate price, paint mixed to any ordinary colour and ready for use, in a tin can or an earthen paint-pot, and in addition the man generally will lend a brush wherewith to apply it. This is useful where but little painting is done; but when the amateur frequently uses paint, it is desirable that he should be possessed of his own brushes and other tools. These tools are very few, and are mostly required for mixing the colours; the materials are the most important consideration, but these on the one hand are not expensive, and on the other may be easily obtained.

The advantages of being able to mix one's own colours, which advantages may be set against those of procuring paint direct from the oil and colourman ready for use, may be stated as

follows: colour can be mixed in a very little time, especially if the materials are at hand; any quantity may be made—just as much as is wanted and no more—when perhaps only a few brushfuls are wanted, whereas ready mixed paint must be bought in certain quantities; and it can be mixed to dry either quickly or slowly, as circumstances may render it desirable.

The requisites for mixing colours are a marble slab or a piece of thick glass, about 18 in. square, glass or marble being specified because the smoother the surface the more effectually the colour can be ground; a muller, also made of glass or marble, and a palette-knife. The palette-knife is a broad but thin and flexible steel blade, set in a wooden handle. An old well-worn table knife will answer the purpose very well. The knife is useful for taking up pigment to put on the slab, for scraping together the colour which the action of the muller has driven from the centre to the sides of the slab, and for transferring the ground colour from the slab to the receptacle in which it is to be placed. This is generally the ordinary painter's can, which can be purchased, for a small sum at any ironmonger's. For mixing paint a fairly large size will be found more convenient than a small one. The amateur should generally possess about half-a-dozen of these cans. A suitable piece of marble or glass for a slab may be procured and a muller made, completing the equipment.

Pigments.—The colouring-matter called pigment, must be bought of the oil and colourman in powder; most pigments are very cheap, although on the other hand some, as vermilion and ultramarine, are most costly; the amateur, however, will require only those most commonly used, which are the cheapest. When buying the pigment he must also procure some *boiled* linseed oil, some turpentine, patent dryers, varnish, and gold size. The amateur must be very careful to get *boiled* oil, as raw oil will not answer; indeed, the use of unsuitable oil is the cause in most instances of the failure of the paint to dry readily. The varnish required is either copal or mastic varnish.

Process of Mixing.—To prepare the paint the powder of the desired colour is laid upon the slab, if lumpy it must be crushed; a little boiled oil is poured on it, and with the muller it should be given a thorough good grinding. There need be no fear of powdering it too fine; because the finer the better. Sufficient oil should be used to bring it to a paste. The circular sweep of the muller will, as it has been said, have a tendency to spread the paint, and even to drive it off the slab; therefore when

any portion of it is rather near the edge, the palette-knife should be used to bring it all in the centre of the slab, ready for further grinding.

Paint not required to dry very quickly, or say before about twenty-four hours, should have a little turpentine and about double the quantity of oil added. Paint mixed in this proportion will look bright when dry, and have a good lustre.

If it is of importance that the paint should dry quickly and still have a bright appearance, it should be mixed with turpentine and gold size should be added afterwards. A paint to dry in twenty minutes or half-an-hour, must be mixed with turpentine and without oil. When dry this paint will have a dead, lustreless appearance, and will require a coat of varnish afterwards to make it look as it ought. This is a method often adopted for iron work. All paint should be rubbed through a fine wire sieve or a piece of canvas to remove any lumps before it is applied.

Dryers.—A little patent dryer added to either of the mixtures will make the paint dry quicker. Gold size also causes paint to dry very quickly. The ordinary dryers most in use are sugar of lead, litharge, and white copperas. Red lead is also an excellent dryer, but this from its colour cannot be used with all paints. Sugar of lead is the most expensive, but it is also the best. It is better not to mix dryers with delicate colours, because the tints are often affected by their introduction. A good drying oil is made by adding two ounces of litharge to half a gallon of linseed oil. The oil should be allowed to boil slightly until no scum is thrown up to the surface; it must then be allowed to cool, and poured in a bottle for future use.

Brushes.—The brushes used by the house painter are distinguished as "brushes" and "sash tools," the larger brushes being included under the former title, and the smaller ones employed in painting sashes, mouldings, and other small work under the latter; the larger brush is used to spread paint over broad, flat pieces of wood, such as the styles, rails, and panels of doors, over which it can be passed very rapidly.

A large dusting brush is used for removing all dust from work prior to the application of paint. The hair of this brush is longer than that of the ordinary paint brush, which is made in three sizes, and either round or oval in form. The brushes are made of bristles set in wood, bound round with string or copper wire. In the wood the conical handle of the brush is also fixed. The oval brushes are said to be preferable to the

round brushes, because they require less working to get them into a suitable shape for spreading the colour smoothly and evenly. To hasten this desired end, painters will often use a round paint brush in the place of a dust brush, until it has been brought into decent working order. The sash tools are made in a number of sizes, and are bound with string, or encased with tin.

Painting New Work.—In painting new work different methods from those adopted in repairing old work are followed. Before beginning to paint *new work*, all projections, such as lumps of glue, etc., must be cleared away. Then all the knots in the wood must be killed with *knotting*, to prevent the turpentine in the knots from oozing out and spoiling the appearance of the painting when finished. The amateur is advised to buy the "patent knotting," which may be had of the oil and colourman ready for use. This dries and hardens very quickly. Then the *priming*, or first coat, is put on. This is made of white lead, with dryers, and a little red lead to harden it. It is made very thin with oil, as unpainted wood or plaster absorbs the paint very readily. Sometimes new wood has applied to it a coat of *clear-cole*, which is a mixture of size and a little whiting. The suction of the wood is stopped by the clear-cole, but the after-coat of oil paint does not adhere to the work as closely as it does when the wood is properly primed. Clear-cole, however, is useful on old and dirty wood which has never been painted, and on which, especially if greasy, oil paint would not dry.

As soon as the priming is dry, all holes made by punching in the heads of nails, cracks, etc., must be stopped with putty. It is useless to attempt to do this before the priming has been applied, because putty will not stick to wood unless the wood has been painted. After this has been done, the *second coat* of paint may be applied; and for new work this should be made up chiefly of oil, because oil is most efficient in stopping the suction of the wood; then a *third*, and even a *fourth coat*, may be applied. When laying on the colour, in the earlier coatings the brush should be passed downwards and upwards, and in every direction, to spread the colour evenly and work it well into the wood. Finally, the brush should be drawn up and down, or backwards and forwards, as the case may be, in the direction of the grain of the wood, taking care to leave no marks of the hairs of the brush. In painting a door or any piece of work in which part is sunk and part raised, the mouldings or any bead-work should be painted first with a sash tool, and then the panels, styles, and rails with a brush. No

coat should be laid on a previous coat until that coat is perfectly dry and hard; and before beginning to paint any work, every particle of dust that may have settled on it should be carefully removed with the dusting brush.

Painting Old Work.—In painting old work the process is somewhat different; but in this, as in the case of new work, the successive steps of the operation will be described in detail from beginning to end.

When about to re-paint old work, all dirt and projecting pieces must be carefully removed, and if the paint appears greasy it should be washed with turpentine. Whenever patches of paint have come away through sun blisters or other causes, the bare parts must be painted over with a coat of priming. All defects must then be stopped and made good with putty, when the new coat may be applied.

When paint appears rough, especially in the case of patches in old work that have been retouched, the surface, when dry, should be rubbed down with fine glass paper or pumice until the roughness has disappeared. All paint that appears loose round the blister-marks should be scraped away with a knife before the putty is put on. For cleaning old greasy smoke-stained paint, lime wash or soda water may be used. This kills the smoke or grease, on which oil paint would never dry and harden. Some will put a coat of weak size over the smoke and grease; the paint will dry on this, but is very likely that the under coat will soon crack and peel off.

The composition of the paint that is applied to old work, and indeed to wood generally, must depend upon the style or manner in which the work is to be finished. The first coat after the priming on new work should be paint in which the oil predominates over the turpentine; but for the first coat for old work the turpentine should be in excess of the oil. Paint mixed with oil in excess will present a glossy surface when dry, but paint mixed with turpentine in excess will present a flat appearance. Therefore, when a glossy surface is required it is necessary that the under coat should be paint mixed with turpentine, the final coat being mixed with oil; but when the finishing coat is to be "flat," as it is technically called, it must be mixed with turpentine and be laid over an under coat mixed with oil.

Removing Old Paint.—It is not desirable to keep spreading on coat after coat of paint on old work. It is better when the successive coats of paint have become very thick, to remove

the paint entirely and get down to the bare wood. There are various modes of removing paint. The professional painter does it by the agency of heat, applying a flame to the surface of the paint; the heat soon softens the colour, and it may then be scraped away with a knife. (See Pl. XXIX, Fig. 4.)

The amateur who does not possess the special apparatus necessary in this method may save himself the expense of purchasing it by adopting one or other of the following modes. (1) Make a very strong solution of common washing soda, and apply it to the paint with a brush until the paint can be scraped away. (2) Slake 3 lb. of quick lime in water, and then add to this 1 lb. of carbonate of potash and sufficient water to bring the whole to the consistency of thick cream. Apply the preparation with a brush, and leave it on the paint for from eighteen to twenty-four hours, when it will be found that the paint is softened and may be easily scraped off.

During recent years, several patent "paint removers" have been placed upon the market, and these are very extensively used by professional workmen. These agents are very efficient, and as they will remove quite a thick coat of old paint in a few minutes, are specially useful where time is an important consideration. There are two classes of them, one of an alkaline, and the other of a spirituous character. The first kind, which is a paste-like substance, is applied with a fibre brush to the old paint which in a short time becomes softened, and may then be scraped off. Any alkali which remains after the process, is neutralized by washing over the surface of the wood with weak acetic acid, and when this has been dried off the new coat of paint may be applied. The second kind is a clear liquid which is still quicker in its action. It is applied in a similar manner, and after the removal of the paint the surface of the wood is cleaned with a piece of rag dipped in benzine. The great advantage of this class of paint remover is that the surface of the wood is not discoloured or affected in any way, and, as no water is used, there is no risk of spoiling the work by raising the grain. Both kinds of these solvents are obtained in small quantities such as may be required by the amateur, and full directions for their use are given by the manufacturers.

Painting on Plaster.—A greater number of coats of paint are required on plaster than on wood, because plaster will absorb more oil than wood will. Thus, if three coats of paint are sufficient for wood-work, four and sometimes five coats will be wanted

for plaster. Less paint is of course required when the plaster has had time to dry and harden properly, and indeed no paint should be put on plaster before it is perfectly dry.

In painting plaster, the first coat should consist of white lead well thinned with oil, and having a little litharge added to it to ensure its drying quickly. The second coat should be altogether similar in character. The plaster will now be saturated with oil to some depth below the surface, and to the third coat may be added some turpentine, and some of the colour with which the walls are to be tinted when finished. The fourth coat should consist of paint of a darker shade than that to be used for the finishing coat, mixed with equal quantities of oil and turpentine. The last coat should be mixed with turpentine only, and a little gold size to harden it and to promote quick drying. This coat, which is called the "flatting," because it dries without gloss, should be somewhat lighter than the selected tint, because it will dry darker. In painting plaster, every successive coat should be allowed to dry thoroughly and remain for some days before the next is put on; the last coat but one, however, should not be allowed to stand more than two days before the finishing coat is laid over it.

Re-painting a Bath.—The first thing to do is to thoroughly clean the bath by scrubbing with hot water and soap, afterwards sluicing it out with cold water. To render the old surface quite smooth, it should be rubbed down with fine glass paper or powdered pumice stone. If it has been chipped, care should be taken that the sharp edges are ground off. If a really good finish is required, it may be necessary to remove the old paint; for this purpose the patent paint removers, to which reference has been made (p. 453), will be found excellent. After the process of glass-papering all dust should be carefully removed, and the surface wiped over with a clean rag and turpentine so as to remove any final traces of grease or dirt. The best paint to use is either white lead or zinc white, mixed without oil, and thinned with turpentine to which a small quantity, about a tablespoonful, of gold size, has been added. This will dry "flat," i.e., without gloss. The paint should be mixed much thinner than ordinary oil paint. If desired, it may be tinted blue or green by adding a little of the colour required, as described in the section dealing with colour mixing. The surface of the bath should be quite dry before the paint is applied. To obtain the best results the bath should have three coats, and sufficient time, about 10 or 12

hours, should be allowed between each coating for the paint to dry quite hard. The varnish used to produce the gloss must be the special bath varnish made to resist hot water. It should be applied uniformly, and as thinly as possible, and when the first coat is quite dry a second coat should be given. After the last coat is dry the bath must not be used immediately, but a few days allowed to elapse for the varnish to set. The bath should then be filled with cold water and gradually warmed up by allowing hot water to flow in whilst the cold runs out. This is in order to prevent the cracking of the surface through sudden exposure to a high temperature. Afterwards, the surface of the bath will stand all ordinary temperatures.

Many excellent bath enamels are now on the market, but as they are often thick and difficult to apply, they are more suitable for the professional painter than for the amateur.

Painting Venetian Blinds.—The tapes should be first taken off and the blind pulled to pieces. Each slat should then be thoroughly scrubbed, rinsed in cold water and dried. A coat of paint should then be given in the manner described in the section on re-painting old work. When the last coat of paint is dry, the work should be varnished. The chief point to which attention should be given is the selection of a colour which will harmonize with the colour of the surroundings. Light greys, blues and greens and buffs will generally be found suitable, but discrimination should be used even with regard to these.

How to keep Paint.—The amateur may find it necessary to do his painting work at intervals, often far between. Paint left in the pot for some length of time, he will discover, much to his annoyance, on resuming work, is too hard and thick to be used. The addition of some oil and turpentine may save a little of it, but it will neither work pleasantly, nor, indeed, be worth using. Whenever paint must be put aside, a little cold water must be poured on the top. This prevents the evaporation of the oil, and keeps the paint liquid for future use by excluding the air and preventing its action in drying and hardening the oil.

Care of Brushes.—Similarly, brushes not in use should have the bristles kept under water, that they may remain soft and flexible. It is better, however, when the amateur painter does not know how long it may be before he uses his brush again, to wash the colour well out of it by means of a little turpentine, and

then to allow the brush to dry. When kept in water for a long time, the constant soaking will rot the string and the bottom of the wooden handle to which the bristles are attached, and on recommencing painting, the brush may snap off short.

Terms for Combinations of Coats.—The meaning of certain expressions used in painting, and the terms used for certain combinations of coats given in painting, and the various kinds of coats that each term implies are as follows—

(1) *Clear-cole and Finish.*—Stop defects with putty, clear-cole and finish with oil to colour as directed.

(2) *Two Coats in Oil.*—First turpentine colour, and second finish oil colour.

(3) *Two Coats in Oil and Flat.*—First turpentine, second oil and third flat.

(4) *Three Coats in Oil.*—First oil, second turpentine, and finishing oil.

(5) *Three Coats in Oil and Flat.*—First oil, second turpentine, third oil and flatting.

(6) *Four Coats in Oil.*—Oil priming, oil second coat, turpentine third, and oil finishing.

(7) *Four Coats in Oil and Flat.*—Oil priming, oil second, turpentine third, oil fourth and flatting.

Colouring Substances.—It will be useful to mention the various pigments or colouring substances used to produce different simple colours, and to follow these with a list of colours that are produced by combinations of two or more of these pigments. White lead is mixed with all colours to tone them down and produce different shades, hues and tints. There are, however, other mineral whites capable of supplying the place of white lead, which have the advantage of being non-poisonous pigments; it will be convenient to classify each set of colouring substances, whether mineral or otherwise, under the colour which it yields when properly mixed.

TABLE OF SIMPLE COLOURING SUBSTANCES.

(1) *Whites.*—White lead, Zinc White (oxide of zinc, non-poisonous).

(2) *Blacks.*—Lamp Black, Ivory Black, Blue Black, Vegetable Black.

(3) *Yellows.*—Chrome Yellow, Naples Yellow, King's Yellow, Orpiment, Massicot, Yellow Ochre, Raw Sienna, Yellow Lake.

(4) *Reds.*—Vermilion (crim-

son and scarlet), Carmine, Cochineal Lake, Madder Lake, Red Lead or Minium, Indian Red, Venetian Red, Spanish Brown, Purple Brown, Orange Lead, Burnt Sienna.

(5) *Browns.*—Umber (burnt and raw), Vandyke Brown, York Brown.

(6) *Blues.*—Prussian Blue, Cobalt, Ultramarine, French Ultramarine, Blue Verditer.

(7) *Greens.* — Verdigris, Scheele's Green, Emerald Green, Green Verditer, Italian Green, Saxon Green, Brunswick Green.

Table of Compound Colours produced by Mixing Simple Colours

Straw Colour.—Chrome yellow and white lead.

Lemon Colour.—Chrome yellow and white lead; more of the first than in straw colour.

Orange.—Chrome yellow and vermilion (bright), yellow ochre and red lead (duller).

Buff.—White lead and yellow ochre.

Cream.—Same as for buff, but with more white.

Gold.—Chrome yellow with a little vermilion and white lead; or Naples yellow and realgar.

Stone.—White lead and yellow ochre, with a little burnt or raw umber.

Stone (grey).—White lead, and a small quantity of black.

Drab.—White lead, burnt umber, and a little yellow ochre (warm); white lead, raw umber, and a little black (cool).

Flesh.—Lake, white lead, and a little vermilion.

Fawn.—Same as for flesh colour, with stone ochre instead of lake.

Peach.—White lead, with vermilion, Indian red, or purple brown.

Sky Blue.—White lead, Prussian blue, and a little lake.

Olive.—Black, yellow, and a little blue; or yellow, pink, lamp black, and a little verdigris.

Chestnut.—Light red and black.

Salmon.—Venetian red and white lead.

Chocolate.—Black with Spanish brown, or Venetian red.

Sage Green.—Prussian blue, raw umber, and a little ochre, with a little white.

Olive Green.—Raw umber and Prussian blue.

Pea Green.—White lead and Brunswick green; or white lead, Prussian blue, and some chrome yellow.

Pearl Grey.—White lead, with a little black, and a little Prussian blue or indigo.

Silver Grey.—Same as for pearl grey.

Grey.—White lead and a little black.

Lead.—White lead with black or indigo.

Violet.—Vermilion, white lead, and indigo or black.

Purple.—Violet as above, with the addition of a rich, dark red, or colours for French grey.

French Grey.—White lead with Prussian blue and a little lake.

Lilac.—Same as for French grey, but with less white.

Oak.—White lead with yellow ochre and burnt umber.

Mahogany.—A little black with purple brown or Venetian red.

In addition to the above it may be said that *greens* of all shades may be produced by the admixture of the various blues and yellows. But, as it has been said, the amateur who is not disposed to mix his own colours may procure any kind of green, and any or almost any of the colours above described ready mixed for use in handy little tins or cans at no more cost than he would have to pay any oil and colourman for mixed colours.

Graining and Marbling.—These branches of decorative work will scarcely be attempted by the amateur. Either, when badly done, is very unsatisfactory, while to do graining and marbling well requires considerable taste and artistic skill and many years of practice. *Graining* is the painting of a common wood to imitate a more expensive one. To do this the colour for the ground which is some light colour, generally buff or stone colour, is first laid on and allowed to dry. When thoroughly dry and hard, a coat of darker, rather slow drying, paint called the overlay, is laid upon the light ground, and while this is wet the surface is diversified by drawing combs of leather or metal and graining brushes over it. These take off some of the dark-coloured paint, and expose the light ground colour. When properly done it has a very good effect, but the amateur, unless he has a natural talent for painting, will find that the chief difficulty in graining is to do it properly.

The leather and metal-graining combs with which graining in imitation of any kind of wood is done, may be bought at comparatively low prices of any oil and colourman. The amateur, indeed, may make his own leather combs, as they are nothing more than pieces of fairly stout leather, notched on the edge. Of course different widths of teeth are required for different kinds of graining. Graining rollers are made for imitating various kinds of wood, but when these are used the effect produced is more monotonous than when the graining is done by hand.

For different kinds of wood different coloured grounds are used.

For example, for *dark oak* a ground of yellow venetian ochre, red and white lead is used; for *dark wainscot oak*, chrome yellow, yellow ochre and white lead; for *light wainscot oak*, yellow ochre and white lead only. The tints to be laid over the ground are, for *dark oak*, vandyke brown and raw sienna, and for *light oak*, burnt umber, finely ground, and raw sienna, mixed with turpentine and linseed oil in equal parts, and a little patent dryers. This overlay must be laid on evenly and smoothly, and the streaks and markings produced by wiping parts of this colour away with the combs already mentioned. The light smudges intended to represent the medullary rays are made by wiping away the colour with a piece of rag or wash leather. Grained work when dry must be varnished.

Marbling, speaking of the commonest kind only, is not so difficult as graining, although to the imitation of verd-antique, jasper, malachite, sienna, porphyry, etc., the same remarks apply that have just been made on graining. Common kinds of marbling are those usually known as white marble and black and gold marble. For the first kind, the surface to be marbled must be painted white; for the second, it must be painted black. On the white surface, veins and streaks of black and grey must be put on with a camel-hair pencil; diversity may be given to these streaks and veins by the use of a feather from a fowl's wing, just as it is, or notched to produce various markings. On the black ground veins of white lead, yellow ochre, and burnt or raw sienna must be made by the same means. The spaces between the veins should be thinly covered with grey or white, diversified with veins of a stronger and more decided white. Instead of a black ground a yellow ground is sometimes put on, which is diversified by broad, strong streaks of black. While the black is still wet, veins are drawn in it with a sharp-pointed stick, which removes the black and exposes the yellow ground below.

Distempering.—Distempering is done with colours prepared with size very much in the same way as whitewash, indeed, whitewashing, as well as all painting done in size is called *distempering*. The difference between painting in oils and distempering is just this, that in the former the colouring matter is mixed with oil and turpentine, while in the latter it is mixed with size and water. Ceilings are usually painted in distemper because a lighter effect is produced than when oil colours are used. Scene-painting is done in distemper, but in this the colours are laid on canvas, or some similar material. Distemper as applied

to house-painting may be laid on wood-work, but it is not likely that it will stand long, for whitewash, when put on wood, soon dries, chips, and peels off. Generally speaking, distemper is applied to plaster only, and then the first thing to be done is to stop the suction or absorbing power of the plaster. Sometimes this is effected by giving the plaster a couple of coats of oil paint before the distemper is put on. This lends a richness to the colouring, but this has the bad effect of increasing condensation on the walls in cold damp weather. The moisture thus condensed will ultimately trickle down the wall in little streams, and stain and otherwise injure the distemper.

The absorbency of the plaster is stopped by mixing about 10 lbs. or 12 lbs. of good whiting with water to the consistency of paste, and then adding to it enough size to bind it with about two ounces of alum, which hardens the distemper, and helps it to dry out solid and even, and two ounces of soft soap dissolved in water. These ingredients must be well mixed and strained through a coarse cloth, or a metal strainer. To ascertain whether enough size has been used, try the distemper on paper and dry it before the fire. If there is not enough size the composition will be easily rubbed off, but if there is enough it will stand any amount of rubbing without injury, except such as soils and stains from dirty hands.

Distemper colours should be laid on with a large flat brush in the same manner as whitewash, it is the better plan to close the doors and windows while the colour is being laid on, and to throw them wide open as soon as this is done. The exclusion of the air during the process of colouring prevents that which is laid on first from drying too quickly, which too often has the effect of showing the joinings of the large patches, in which the colour is laid on. The admission of the air as soon as the colouring is completed causes rapid evaporation of the moisture, and renders the whole surface uniform in tint. Of course the colour must be laid on evenly and smoothly, and the same consistency must be preserved throughout. Attention is necessary to the quality of the size used in mixing colours for distempering. Good size may be bought of any oil and colourman.

In making colours for distempering, a wash must first be made of whiting forming a whitewash for ordinary purposes. The size must then be melted and added when warm, to bind it. Then add sufficient colouring matter to bring the wash to the tint required, using, for *pink*, rose pink; for *salmon*, venetian red; for *lilac*, a little indigo and rose pink; for *light grey*, lamp

black; for *French grey*, Prussian blue and lake; for *blue*, Prussian blue, indigo, or cobalt; for *green*, emerald green, or Prussian blue or indigo, and a little chrome yellow or yellow ochre; for *buff*, yellow ochre, to which a little venetian red must be added if a warm tint be wanted; for *drab*, burnt or raw umber.

Stencilling.—Walls and ceilings coloured in distemper are suitably ornamented by stencilling. The pattern is cut in thin sheets of metal, or in stout paper; the perforated plate, whatever may be the material of which it is made, is then laid against the wall, and a brush charged with colour is passed over the openings. The pattern is then removed quickly and carefully, and the design appears imprinted on the wall. In removing the plate care must be taken to remove the card by a direct forward motion, lifting it from the wall and not sliding it off, as otherwise the sharpness and clearness of the outline will be destroyed.

Staining and Varnishing.—Staining and varnishing is preferable to painting for some wood-work in the interior of a house and for exterior work under some circumstances, partly on account of the ease with which it is done, and partly on account of the durability of this mode of finishing wood-work, owing to the hard surface which is imparted to it by the varnish. Re-painting is rendered unnecessary, and the work never requires to be re-stained; the old coat of varnish may be cleaned, and when the surface appears to want freshening up a new coat of varnish may be applied.

Three distinct operations are comprised in the process of varnishing.—first, *staining*; second *sizing*; and third, *varnishing*. The wood should be rendered as smooth and even as possible with the plane, and all knots covered, and nail-holes filled by mixing a little of the stain with plaster of Paris till it assumes the consistence of paste; sappy portions of the wood should be damped with water. The stain may then be laid on plentifully with a brush *along the grain of the wood.*

When the wood is thoroughly dry, it must be twice sized, using each time a very strong solution of size in the proportion of 1 lb. to a gallon of water. The amateur is cautioned against using size stronger than this, and he must not work his brush up and down when charged with size, for this, when the size is too strong, often produces a lather on the wood. It is best to apply size warm, and work the brush in one direction only, from top to bottom or from one side to the other, as may be necessary. If

an interval of twenty-four hours be left after staining, before sizing, the colour is softer and richer. As the resulting effect depends mainly upon the grain of the wood, well-seasoned wood of beautiful figure and variety in the grain should be selected for choice work. When the second coat of size is thoroughly dry the work must be varnished. Exterior work should be sized once and varnished twice; and for rough work, boiled oil may be used instead of varnish.

Different stains can be mixed to obtain a modification of their respective colours, and they may be diluted with water to produce light shades. One coat of walnut stain upon the best pine produces a good resemblance to the very best English walnut, and two coats to the deep-coloured foreign walnut, under this stain the pine grain showing the dark streaks characteristic of walnut-wood. Where a great depth of tint is required, as in imitations of Spanish mahogany, two coats of these stains may be applied before sizing. The white woods, such as ash, beech, bird's-eye maple, elm, and American birch, owing to the greater boldness and variety of their grain, present, when stained, a richer appearance than any of the coloured woods.

In all operations of painting, staining, varnishing, etc., it is of the greatest importance that everything used, whether slab, muller, knife, or brushes, should be kept thoroughly clean. Directions have already been given for keeping paint and brushes from the hardening action of the air, by covering the former with, and immersing the latter in, cold water. This plan should always be followed when but short intervals elapse between successive usings of the paint and brushes. When the painting is finished, and the brushes are to be laid aside, they should be cleaned immediately after using, and while the paint is still moist; then little difficulty will be experienced in cleaning them; but if left until paint or varnish is dry and hard, it will be both a troublesome and an unpleasant job to get them to a proper state. Brushes should never be allowed to harden. If paint brushes cannot be cleaned just after use, they should be kept in water until it is convenient to clean them properly. If cleaned whilst moist a little soap and water will make them as good as new. They are sometimes kept with the hair imbedded in a lump of grease, to prevent them from getting hard.

The same precautions must be observed with regard to the brushes used in varnishing as for painting. If put away wet with varnish, after remaining unused for a day or two they will be hard and utterly useless; they must therefore be well washed

immediately after use, and will then be in proper order when again wanted.

Polishing.—Polishing very greatly improves the appearance of articles made of any fancy wood or stained work. There are many different sorts of polish; but those for which recipes are given below will be found to answer the amateur's purpose in every way.

French Polish.—(1) *French Polish.*—Spirits of wine, 1 pint; gum sandarac, ¼ oz.; gum lac, ⅛ oz.; gum shellac, ⅛ oz. Bring the mixture to a gentle heat; frequently shaking it until the gums are dissolved.

(2) *Naphtha polish.*—Wood naphtha, ½ pint.; orange shellac, 1 oz.; dragons' blood, ¼ oz.; benzoin, ¼ oz. Prepare in the same way as French polish.

(3) *Shellac polish.*—Orange shellac, 1 oz.; spirits of wine, 1 pint.

The method of applying these polishes is the same for all. A flannel rubber is made and dipped in the polish, and a piece of fine and old linen is then put over the rubber. When the polish oozes through the covering dip the pad into or slightly moisten it with linseed oil. Another way is to strain the linen over the flannel pad, and then to moisten the linen with a drop or two of the polish, and a drop or two of oil. The pad should be held in the right hand, and the linen strained tightly so that the pad may present a rounded surface. Apply the pad to the surface of the wood in a series of light strokes made by a circular sweep of the hand until the surface is nearly dry, when the pad should be passed up and down in the direction of the grain of the wood. When the rubber is dry some more polish and oil must be put upon it in the same manner as before and the rubbing continued. Plenty of what is generally called "elbow-grease" should be given to the work, and not too much polish. Beginners generally lay on a large quantity of polish, but this does not look well, neither has it a permanent effect.

No more polish should be laid on than is absolutely necessary: the polish should be well rubbed in and finished off with a little pure naphtha or spirits of wine, whichever happens to be the spirit that is used in the polish. The spirit should at *first* be laid on very gently and with great care, otherwise it will dissolve and remove the polish already laid on; but if proper care is taken its effect will be not only to give the polish a better gloss, but to render it more lasting. Some woods absorb a great deal

of polish. In order to prevent this absorption a bodying-in coat of gold size is given before the application of the polish. When polishing mahogany or other ornamental or coloured wood, should there be any inequalities or faults in any conspicuous part of the object, fill them up with stopping, consisting of plaster of Paris mixed to the consistency of cream with water, tinted with staining or colouring matter corresponding with the colour of the article that is to be polished. A mixture of putty, consisting of finely-pounded whiting and painters' drying oil and some colouring matter, will do quite as well. For large holes a composition of beeswax, resin, and shellac is found very useful.

Gilding.—Gilding may be described as the art of covering any substance or a portion of it, such as wood, plaster, leather, and paper with thin *leaves* of gold with the aid of gilders' size. It will be necessary here to describe briefly the materials used in gilding—that is to say, the gold leaf and gilders' size; the tools by means of which the leaf is applied to the surface to be gilded; and the processes known as oil gilding and water gilding.

Good gold leaf consists of gold beaten out by the gold-beater, to extreme thinness. Even the best gold is alloyed with silver or copper because pure gold is too soft to be worked between the vellum sheets or gold-beater's skin in which it is necessary to confine it during the process of beating. When beaten out thin enough for use the gold is placed between the leaves of small books about 3½ in. square, red bole being rubbed over the leaves to prevent the gold from sticking to the paper; each book contains twenty-five leaves. Inferior descriptions of gold leaf are made, which are sold at about half the price of the best, and "Dutch metal" is sometimes used as a substitute for gold leaf in cheap and common work. Dutch metal is copper coloured yellow.

The sizes used by the gilder are known as *gold size* and *fat-oil gold size.* The former is composed of 1 part of yellow ochre, 2 of copal varnish, 3 of linseed oil, 4 of turpentine, and 5 of boiled oil thoroughly incorporated. Before the yellow ochre is mixed with the other ingredients it must be reduced to the form of very fine powder, and ground up with a little of the linseed oil. Fat-oil gold size is made by grinding stone ochre reduced to a very fine powder with old fat linseed oil. This should be made and kept for some years before it is used. As it is ground up very stiffly so as to present the appearance of stiff paste, it must be mixed with a little fat boiled oil before it is used.

Plate XXIX PLUMBING etc

Plate XXX SOLDERING AND BRAZING

(1) Cleaning the surface ; (2) Soldering with copper bit ; Brazing

The tools required in gilding are a cushion, a knife, a tip, some camel-hair brushes, and some cotton-wool. The cushion is a piece of wood about 8 in. long and 5 in. wide, having loops underneath, through one of which the thumb is thrust in order to hold it, while the others serve to hold the knife and camel-hair brush. The top of the wood is padded with three or four thicknesses of baize or woollen cloth, over which a piece of wash leather is tightly stretched. Along the back and one of the sides is a parchment ledge 3 in. high, which prevents the gold leaf from being swept off the cushion by any chance current or puff of air. The knife is a long, thin, flexible blade, set in a wooden handle like a palette-knife, and is used for cutting the gold leaf into pieces as may be required after it has been placed on the cushion. The tip is a broad, flat brush of squirrels' hair inserted between two pieces of card, and is used for taking up the gold leaf from the cushion, and placing it on the size. The camel-hair brush and cotton-wool are used for pressing the leaf into hollows and depressions, and for brushing away superfluous gold leaf.

Oil gilding and water gilding are thus distinguished because whilst in the former method the object to be gilded is sized with glue size, and covered with two coats of oil paint, and one of flatting, generally of a red or yellow colour, in water gilding the wood is covered with several coats of whiting and size, until a perfectly smooth and substantial coating is produced. Oil gilding will bear washing with water, and is always of the natural colour of the gold, generally spoken of a " dead " or " neat " gold. Water gilding will not bear washing or wetting in any way; but may be burnished to brightness with a burnishing tool of agate. Oil gilding cannot be burnished.

The surface of the material to be oil gilt must be rubbed smooth, painted, and flatted. Some size must then be strained through muslin, and a little put on the palate and coloured with yellow ochre or vermilion ground with it. The surface, or such parts of the surface as are to be gilded, must then be coated with size, applied with a stiff brush of hog's hair. The size must be laid on smoothly and in sufficient quantity, but not too thick. When the size has hardened sufficiently so as not to come off when touched, but merely to feel " tacky," the gold leaf may be applied. To gild the surface, leaves of gold must be shaken out, of the book upon the cushion and each in turn must be laid out. and flattened and cut in pieces, if necessary, with the knife. The tip must then be passed over the hair of the head, to render it slightly greasy, and applied to the gold, which will stick to

it, and is thus removed from the cushion and laid on the size. When the surface, or such parts of it as are to be gilded, are covered with the gold leaf, it must be firmly pressed into its place with cotton-wool or the camel-hair brush, or flattened down with a hogs' hair brush, applied as in stippling—that is to say, by dabbing the points of the bristles on the gold. Nothing now remains to be done but rub the gold over lightly with a piece of clean wash-leather. When japanners' gold size is used instead of oil size, the gold leaf may be applied about half an hour after the size has been laid on, or in about three or four hours if a mixture of one-third oil size and two-thirds japanners' gold size has been used.

In *water gilding*, the surface given to the wood by successive coats of size and whiting is covered with gold size made of American bole, a little white wax, and some good parchment size. The size must be allowed to dry, and then clean water must be applied to it with a soft brush, and the gold laid on the wetted surface. The leaf will adhere immediately to the size. When laid on, it has the dead appearance always shown by oil gilding, but any portion of the gold, or the whole of it, may be burnished to brightness by rubbing it with an agate burnisher. Frames gilt in this way cannot be regilt by this mode of gilding without removing the coatings of size and whiting, and going over the whole process again from the very beginning. It must be remembered that water gilding will not bear washing, and must be protected in summer time from fly stains, etc. The gilding of small articles has been greatly facilitated by the production of gold paint which is obtainable of colourmen. This consists of bronze powder mixed with some transparent vehicle which holds the particles together and causes them to adhere to the groundwork. When applied to any surface such as that of a picture frame it dries with all the appearance of gold leaf. In using these paints every care must be taken to see that the surface is clean. When one bronze paint is applied over another it often turns black in a very short time. This is due to the difference in the chemical composition of the medium used in mixing the "paint." All old surfaces should be first rubbed down with fine sandpaper and then painted over with patent knotting or zinc white paint to which a little yellow has been added. When this is dry the new gold paint may be applied, and if of good quality will retain its brightness for a considerable time.

CHAPTER XI

PAPER-HANGING, AND HOW TO DO IT—GLAZING, OR WORKING WITH GLASS

IN describing the plant required and the method to be followed in paper-hanging, there are certain points to be considered which may be set down as follows: firstly, the wall or ground-work on which the paper is to be hung, and the modes of preparing it to receive the paper; secondly, the tools that are necessary; thirdly, the method of hanging paper; fourthly, various modes of treatment by which the appearance of paper-hangings may be improved; and, fifthly, how soiled wall-papers may be cleaned, or at all events freshened in appearance.

Wallpapers.—But before entering on these points, let us see what wall-paper is and how it is printed, or, technically speaking, "stained," the different descriptions of wall-papers, the use of borders, and the choice of papers for decorative purposes, which vary considerably in quality, design, and colour. There are two kinds of wall-paper used in paper-hanging, one being of English and the other of French manufacture. The French paper may be distinguished from English papers by their narrow width, the English papers being 21 in. wide and the French papers only 18 in. Again, a "piece" of English paper is 12 yards long, and a piece of French paper about 9½ yards, the former covering 7 square yards or 63 ft. superficial, and the latter 4⅔ square yards, or 41 square feet. Approximately, therefore, where two pieces of English paper are required, three of French will be wanted at the very least, and in practice this will be found not to be enough.

How to Measure a Room for Papering.—The pattern on wall-paper does not come quite out to the edge, so that in measuring a room for paper it must be remembered that 21 in. in English papers and 18 in. in French papers is the absolute net width of the pattern itself; the actual roll of paper is wider than this. To measure a room, cut a short rod or stick 21 in. in length, and pass it over the four walls of the room, beginning in one corner and ending in the same, *omitting only to measure the width of the window and the door with the rest of the room.* This is a simple and useful method for ascertaining the quantity required approximately, for the part that is allowed for the fireplace by this mode of measurement will, generally speaking, be enough to cover the space above the door. and above and below the window, and

occasionally there will be dwarf cupboards in recesses, making spaces where no paper will be required.

To give an example of this mode of measurement, supposing that the room is 18 ft. by 15 ft., the whole circumference of the walls will be 66 ft., and supposing the door and two windows to measure, the one 3 ft. 6 in., and the others 3 ft. 9 in. each, will have to be reduced by 11 ft., showing a space of 55 ft. to be covered with paper. Measurement with the 21 in. rod will show that thirty-two breadths of paper are required—that is to say, thirty-two strips of paper 21 in. wide. On the length of the strips, then, will depend the quantity of paper required. Suppose that the height of the wall between the skirting-board and cornice is 9 ft.; then as the "piece" of paper is 36 ft. long, it will cover four breadths; and as thirty-two breadths have to be covered, eight pieces of paper will be required. Had the height of the wall between skirting and cornice been 10 ft., then a piece of paper, approximately speaking, would only cover three and a half breadths, and a little more than nine pieces would be required and so on. Another method is to measure the circumference of the room, making allowance for doors and windows, and having ascertained the number of feet, multiply this by the height of the room and divide by the number of square feet in a piece of paper. Thus, taking the room as before to be 18 ft. by 15 ft. and allowing 11 ft. for doors and windows, and taking the height of the room to be 9 ft., between skirting-board and cornice we have:

18 ft. + 18 ft. + 15 ft. + 15 ft. (length of 4 sides of room) − 11 ft. (allowance for door and windows) × 9 ft. (height between ceiling and skirting) ÷ 63 (no. of square feet in piece of paper).

Or $\overline{66 - 11} \times 9 \div 63$, or $55 \times 9 \div 63 = 8$ pieces, or a trifle more, as before.

But in wall-papers, as in all other kinds of material, there must be waste, and the waste will depend partly on the height of the room and partly on the length of the pattern; this length of pattern is shown on one if not on both edges of the piece by printed marks that will be readily recognized by the amateur, now that their existence and meaning is pointed out to him. The smaller the pattern the less will be the waste, because the recurrence of the pattern is more frequent; and conversely, the larger the pattern the greater the waste; but then, again, it may happen even with a large pattern that the height of the room is such that the paper will cut in such a manner that the waste will be small. But it is always customary to allow one piece

in seven for waste. When buying papers it is well to have at least a piece or two over for repairs, for this will often save the necessity of re-papering the room when the paper has been damaged here and there.

Wall-paper is made in lengths of 12 yards as described, and the patterns are imprinted on the paper by means of blocks, generally speaking, although some papers are painted in part by hand. Common, low-priced papers have the ground of the paper, which is either white, pale brown, yellow, or grey, to form one of the colours of the design and on this one, two or more colours are imprinted so as to form a pattern. In cheap papers seldom more than two colours are used, and these are generally blues, purples, greys, and drabs. Cheap papers are not recommended if the amateur himself is going to do the paper-hanging, for they are so flimsy when damped with the paste that they will scarcely bear handling. A satisfactory kind of pattern for general purposes is a small geometrical one, consisting of some simple form, a leaf or flower, conventionally treated. For staircases, passages, etc., papers in imitation of wood or marble are commonly used, and these can be preserved from much casual injury by varnishing. Marble papers are usually hung in large blocks, the lines of demarcation, horizontal and vertical, being first traced on the wall by the aid of a straight-edge, in black or brown. For sitting-rooms satin papers, or papers with a glossy surface, are generally used. The papers in which gold is introduced are expensive if the quality is at all good. In cheap papers, the gilt, which is probably Dutch metal, soon tarnishes and in course of time changes first to a dull copper red and then to black. This is particularly the case in the chemically charged atmospheres of large towns and industrial centres.

Preparation of Wall.—From the material with which walls are covered, we may pass on to the wall itself, or the ground on which the paper is to be hung. If the wall be new it will require sizing before the paper is put up. If the wall has to be re-papered, it must be stripped of the old paper, though new papers are but too frequently hung upon old papers ; a procedure which is certainly not cleanly, and is in many cases prejudicial to health, because the dampness caused by putting up the new paper often detaches the old paper from the surface of the wall, and oftentimes, if the paste used in hanging the old paper has been bad, a fungus is generated, which spreads over the wall in dark patches of a brown or greenish colour.

In re-papering a room after it has been occupied by a person suffering from an infectious illness, on no account should the old paper be left on the walls, but it should be carefully stripped and the walls washed, and the ceiling coated with limewash, after the old coating has been taken off with clean water. As soon as this is done, the walls may be sized and the process of re-papering may be proceeded with.

It may happen that the surface of a wall is too damp for papering, or that it has not been plastered, or having been plastered shows spots and patches of damp here and there, which would soon take the colouring out of any paper pasted over it, and eventually destroy the paper itself. When this is the case, the surface of the wall must be either dressed with some preparation that will present a surface impervious to damp, or covered with a framework on which canvas may be stretched, and between which and the surface of the wall a current of air may be constantly circulating, drying the wall and preventing the canvas itself from contracting damp and showing those signs that bear unmistakable witness to its presence.

With reference to curing damp in walls, various preparations for use inside and out have been already given in these pages. For internal use on plaster there is nothing better than a varnish made by dissolving shellac in naphtha. The smell is objectionable, it is true, but the result is all that can be desired. The liquid, when applied with a brush, soon hardens into a dark red solid coating, impervious to water, and on which paper may be pasted without fear of injury.

If the damp parts of the wall cannot be well treated in this manner, the wall must be battened; that is to say, strips of wood 2 in. wide and ¾ in. thick, must be nailed to the wall at intervals of about 18 in., and over these battens canvas must be stretched. To get a surface as uniform as possible, the strips of canvas should be sewn together selvedge to selvedge. Whenever the canvas crosses a batten it should be nailed down to it with tin tacks or zinc nails, flat-headed and as short as possible, and the joinings of the canvas should have strips of brown paper pasted over them to hide the stitches in the seams. The canvas should be damped before it is stretched on the battens; it will soon dry, presenting a surface as tight and well strained as the vellum head of a drum.

When the ground-work, whether wall or canvas, on which the paper is to be hung is ready, the space to be covered with paper may be sized, though this is not essential. The size should be

applied warm, and with a large brush, which should be passed once or twice over the wall or canvas. Care must be taken not to work the brush up and down too quickly or with too great pressure, as this has the effect of making the size lather.

Paper-hangers', Tools and Appliances.—The tools absolutely necessary for the paper-hanger's work may be summed up as a pair of boards connected by hinges, or, if preferred, simply grooved and tongued together, or even joined by dowels, which when supported on trestles, form a suitable table on which the strips of paper to be pasted may be laid face downwards one above another. The amateur need not provide himself with a pair of boards and trestles merely for the sake of papering a single room; a kitchen table, or even a dining-table suitably protected, will answer every purpose. The boards are portable, and therefore useful to the regular paper-hanger, who may not find any suitable table at the house to which he is going. They are also of greater length than most tables, which is obviously an advantage. The amateur must of necessity have a pair of good-sized scissors; a clean pail to hold his paste, and a paste brush, something similar to that used for white-washing, but smaller.

Paste for Paper-hanging.—Good paste for paper-hanging is made of rye flour, mixed to a milk-like consistency with water. When put in the saucepan to boil, a little size or glue may be added, which will increase its tenacity. This, however, is only required when dealing with stiff or thick papers. It should not be used with ingrain papers or "gold" papers. In the former case, it causes the colour to fade and in the latter it turns the gold black. A little alum may also be added to paste—this ingredient has the property of keeping paste sweet and wholesome. When boiled the paste should be of the consistency of ordinary gruel.

Another method of preparing paste is to take ordinary white flour, place it in a basin and add a sufficient quantity of water to make a stiff batter. This mixture should be beaten up with a stick until it is quite free from lumps and then thinned with a little additional cold water. When all lumps have disappeared boiling water should be slowly poured in until the paste thickens, and it is then right for use. It should never be used while hot, but always allowed to stand for some time to cool. To preserve the paste a few drops of oil of cloves or carbolic acid may be added. Paste must be laid on the paper smoothly and equally with backward and forward strokes of the brush. Care should be taken not

to load the brush with very much paste at one time lest the paper should be rendered too damp. It will sometimes happen that through an over-abundance of paste a little is pressed out at the edges when the cloth is used to press the paper against the wall. Any paste thus making its appearance should be removed by means of a sponge dipped in clean water, but the amateur must do his best to avoid smearing the colours of the paper. The colours will often be started in a slight degree by the influence of the damp paste, and if the surface be smeared the only thing that can be done is to paste a piece of fresh paper over the smear, which, if left as it is, will prove a continual eyesore.

If the surface of the wall is clean, smooth, and level, all that need be done is to coat the plaster or canvas with weak size. This is done because paper will stick better to a sized surface than to unsized plaster or canvas. If the wall has been distempered, the coating that it has thus received should be wetted with a brush dipped in clean water and scraped with a piece of iron, such as a plane-iron, having a sharp smooth edge without notches. After scraping, the wall may be swept down with a stiff broom. If it happens that there are any loose bits of plastering, such as may have been produced by driving nails into the wall, these must be removed altogether, and the depressions made good with plaster of Paris; or they may be well sized and pieces of thin but strong paper pasted over them. All cracks or holes should be filled with plaster of Paris, or have strips of paper pasted over them. Time should be allowed for the patches to dry so that the plaster may not affect the colour of the new paper. After this the room may be sized for papering. In all cases when a room is to be re-papered it is advisable to damp the old paper and remove it entirely.

Where to Begin to Hang Paper.—Where to make a commencement in hanging a room with paper may be a bit of a puzzle to the amateur paper-hanger. The general rule is, that the paper must be hung from either side of the window round the room, the junction being finally effected in some corner of the room or some recess where the mismatching of the pattern will not be noticeable. It generally happens that of all parts of the room, the chimney occupies the chief point of view. When this is the case, it is desirable that the pattern on both sides of the chief central object should be similar. To effect this, find the centre of the chimney breast and at this point find the perpendicular by the aid of a plumb-line. Having cut a length of paper

sufficient for the purpose, *divide it in the centre of the pattern*, either by making a crease which will come out when damped, or a pencil line down the back, and having pasted it fix it to the wall so that the crease or pencil mark directly coincides with the perpendicular shown by the plumb-line. Half of the piece will then be to the right and half to the left of the centre of the chimney breast. The edge or edges of this piece of paper will perhaps not have been trimmed, but the edges of succeeding strips must be trimmed according to requirements, it being the rule to let the clean cut edge of all lap joints face the light. The outside end of the roll of wall-paper is always the part that should go uppermost. It is as well to mention this, although in the majority of papers the appearance of the pattern itself will be sufficient to indicate it.

Preparation of the Paper.—The point at which the commencement is to be made having been settled the next step is to prepare the paper for hanging. First it will be well to settle where the finish is to be made, that is to say, in what inconspicuous place the paper advancing from both sides is to meet and join; and to prevent waste it will be necessary to take the measuring-rod and ascertain how much of the paper must be trimmed on one edge, and how much on the other: in either case, whether the commencement be made on both sides of the window, or with a central slip over the fireplace, the mode of procedure must be the same.

When it has been ascertained by actual measurement how much paper is required for hanging on each side of the piece first hung, wherever it may be, whether on each side of the window or over the mantel-shelf, proceed to cut the paper. A convenient way of doing this is to sit on a chair and unroll the paper till the roll rests on the feet. With a fairly large pair of scissors, cut off the edge on the right-hand side and roll up the paper with the left hand as you proceed (see Pl. XXI, Fig. 1). The end of the roll being reached, trim the other edge, proceeding in the same way until the paper is rolled as it was before the trimming commenced, having the topmost part at the outer end. It is important to remember that whichever side is trimmed close to the pattern, the opposite side must not be trimmed closer than from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. of the pattern. The edge that is not cut close need not, in point of fact, be cut at all; the chief object in cutting it is to leave as small an extent of overlapping as possible where the strips are joined together.

Ingrains, or self-coloured papers, where there are no guide marks should be trimmed when the paper is cut into lengths and laid on the table. A straight edge, measuring the whole length of the table, should be used and a mark made all along with the end of the scissors.

When the edges are trimmed the next step is to cut the paper into lengths suitable to the height of the room, and this, whether the overplus at top and bottom be much or little, must be done in such a manner that when the second strip is pasted up by the side of the first the pattern will join neatly and exactly, leaving the least possible traces, if it leave any, of the line of junction. The "match" is shown by certain marks on the edge of the paper, and if it be found that a considerable length of paper be left either at top or bottom, or at both, it will be better and more convenient for the amateur in carrying out the operation of hanging each slip to cut off the surplus paper, leaving no more than an inch or two at top and bottom beyond the length between skirting and cornice. Cut the paper straight across, which can be easily done by aid of the pattern, and cut as many lengths as will suffice for one or two sides of the room to begin with. Lay the lengths thus cut face downwards on the pasting-board, letting the edge of each strip as it is laid down project a little beyond the edge of that which is immediately below it. This prevents the paste from getting under the edges of the piece below when the piece above is being pasted.

Pasting and Hanging the Paper.—As many strips as may be required having been laid one on top of another on the board, the first strip may be pasted, but a little judgment must be used as to the time that may be allowed to elapse before the paper is attached to the wall. If the paper be thin and unsubstantial, it must be hung as quickly as possible after the paste is put on; but if it be a stout paper, some two or three minutes may elapse between pasting and hanging; and a thick paper, especially when glazed, may be left even twice as long, to allow the damp to penetrate the paper and render it more easy of manipulation and less liable to be crushed or broken. For easier manipulation it is better to loop up the lower end of the paper, the paste causing the paper to adhere slightly where one part comes in contact with another. Then fold back the top and putting the hands, which should be perfectly clean and free from paste, under this fold, as shown in Pl. XXXI, Fig. 3, attach the paper to the wall, bringing the top upwards to meet the cornice (Fig.

4). Care should be taken beforehand to make a perpendicular guide line on the wall, or to see that the wood-work round the window is perfectly upright, and this will assist the amateur in fixing the strips truly perpendicular. After attaching it lightly to the wall the plumb-line may be applied to see that the pattern is true and vertical, and if all is right release the fold, and after letting the paper hang straight down lift it away from the wall, except for about 6 in. or 8 in. below the cornice, and then let the strip go, when it will gently float down into its place.

The next step is to press the paper against the surface of the wall in every part, and for this purpose the amateur must be provided either with the special brush generally used or with a clean soft cloth. First of all, the paper must be pressed down the middle from top to bottom with firm but gentle pressure, avoiding all rubbing, which may have the effect of starting the colour and smearing and spoiling the paper. Then press from the centre outwards on both sides in a downward direction (Fig. 5). The paper in some cases will lay smooth and flat against the wall, but if the paper be thin there will in all probability be many wrinkles all over the surface. Do not attempt to press these flat. The paper has stretched under the influence of the moisture of the paste, and as it dries it will contract again and lay as flat as possible all over the wall to which it is attached. Lastly, draw the scissors over the paper just below the cornice and just above the skirting-board, making a crease. Then pull the paper gently from the wall as far as may be necessary, cut off the edges along the crease made by the scissors, and restore the ends to their places, dabbing them lightly as before with the cloth, which should be so doubled up as to form a large, loose pad. The second strip may now be put up in the same way. Here, however, the chief care will be to match the pattern neatly, for if the first strip be put up perpendicularly, the other strips will be perpendicular as a matter of course. Nevertheless it will be as well for the amateur to test his work occasionally with the plumb-line, to make sure that it is not getting out of the perpendicular. If the amateur is not successful in his first effort, then all that can be done is to sacrifice the strip of paper, pull it down, and try again. As in everything else, practice is necessary to enable this kind of work to be done well and quickly. It will be advisable, then, for any beginner to try his 'prentice hand in an attic or some small room of little consequence, in order to give him some idea of the way in which paper must be

handled and attached to the wall. He will soon gain confidence in himself, and find no great difficulty in papering other rooms where it will be absolutely necessary that the work be neatly and accurately done.

Unless the cornice be coloured in parts, having the principal tints in the paper repeated in it, the line of junction between the paper and the cornice above and the skirting-board below seems hard and abrupt; and if this be the case when a cornice intervenes between paper and ceiling, it is still more so when there is no cornice, and the vertical planes of the walls abruptly meet the horizontal plane of the ceiling. It was a feeling of this kind that led in the first place to the addition of borders to paper-hangings, which has the effect of diminishing, if not of entirely removing, this abruptness.

Borders.—If borders are used they should be neat in design, and match the paper in this respect and in colour, or if the colours do not harmonize they should be in agreeable contrast. Borders are expensive in comparison with the ordinary wall-papers. A cable pattern generally looks well, or the Grecian rectangular pattern, known as the Greek key pattern. The representation of a simple moulding is often very effective, and when the paper is plain in character and geometrical in pattern a floral border is admissible. It must be remembered, however, that a border tends to detract from the apparent height of the room, and therefore is not so well suited for a low room as for a high room, to which the horizontal lines of the border impart an appearance of breadth and space. A small and simple gilt moulding, which may be carried round the room above the skirting-board and under the cornice, or at the junction between the walls and ceiling where there is no cornice, makes a very effective finish. The gilt moulding does not separate a coloured cornice from the paper in the same conspicuous manner as a border, and it shows up the paper in much the same manner as a gilt frame shows up an oil painting.

Imitation of Dado.—In the imitation dado style, the dado and the paper covering the upper part of the room called the filling are put on first, and the chair-rail or broad line of demarcation between the two last of all, care being taken to indicate its position by marks carefully adjusted by means of level and straight-edge, so that it may be either truly horizontal or parallel with the floor, though this does not always mean the same thing, when pasted up in its place. When a room is to be

panelled, the surface of the walls must be duly marked out so as to show the position and size of the panels, and the width of the styles and rails of the framing, before any paper is put in its place. All this is a mere question of accuracy in drawing the horizontal and vertical lines marking out the respective parts; and it is obvious that unless this be well and truly done, and the lines carefully followed when drawn, the work will be in vain, as anything out of the straight, whether vertical or horizontal, is most offensive to the eye. When the walls have been fairly marked out, the paper that composes the panels may be pasted up, and that which forms the styles and rails of the framing, taking care always that the corners of the styles and rails where they meet are properly mitred, unless corner-pieces specially made for the purpose are used. This done, the mouldings that cover and hide the junction of the other pieces of paper are put on, care being taken as before that they are accurately upright or level, and that the corners are properly mitred.

Of course there are various styles of panelling in paper for rooms, but that which has been described will afford the key to the method of putting up all. An effective decoration in this style for a large room is formed by panels of pale green or rose-coloured paper covered with a diaper pattern in a darker or lighter tint, and edged by a gilt moulding, the styles and rails of the framing being formed of wreaths or lines of red and white roses on a pale, warm grey or cream-coloured ground, the latter being preferable. This style of decoration, however, is not well suited for the display of more than a few pictures—one, two or three, as the case may be—within a panel, but their position is always governed and regulated by the panels. The pictures, in fact, spoil the effect of the panels, and the panelling carries the eye away from the pictures.

How to Clean Wall-paper.—Dust will cling to any surface, and to paper-hangings as readily, if not more so, than any other. The best method of cleaning paper is to sweep down the surface with a soft white cloth tied over the head of an ordinary sweeping-broom, and then to rub the paper lightly all over with stale bread, using for this purpose a loaf cut in four pieces. Baker's dough or flour and water mixed to a stiff dough answers the purpose equally well. A good plan is to add about a quarter of the bulk of plaster of Paris to the flour as this renders it firmer to work with and holds it together. The dust has an affinity for these cleansing substances, and is carried away by them, until the

surface of the bread or dough is so thoroughly impregnated with dirt that paper is soiled rather than cleaned by contact with them.

Grease marks on the paper may be removed by mixing a little Fuller's earth into a paste and placing it over the grease spot; when this is quite dry a hot flat iron should be held so that it is nearly touching the covering of Fullers earth. The grease melts, and is quickly absorbed and the Fuller's earth may then be brushed off.

Varnished papers do not catch and hold the dust so much as those that are not varnished, owing to the smooth gloss imparted in the former case to the paper. The wall-paper should first be sized with two coats of good, clean parchment size, after which it may be varnished and it should receive two, if not three, coats. Varnished paper is especially suitable for halls, passages, etc., as the varnish renders it extremely durable, and gives a surface that may be washed with lukewarm water and a little soap, used sparingly and with caution.

Glazing.—The amateur's work in glazing will be confined chiefly to mending broken windows in house, greenhouse, or frame-light. He will seldom do any glazing on a large scale, unless it be necessary to re-glaze a frame-light for cucumber-frame or any cold pit or place protected by glass, or to glaze a small greenhouse.

Kinds of Glass used in Glazing.—With regard to glass, the English-made kinds that are chiefly used in glazing are crown and sheet glass: these sorts are most in request for window-sashes and glazing generally; but for shop-windows and for the better kinds of houses plate-glass is generally used. Crown glass is made circular in form, with a thick lump called a bull's eye in the centre. Before it is sent out it is cut into two pieces of semi-circular shape, one larger than the other, because the line of division must run on either one side or the other of the bull's eye. Crown glass is not much used now, but formerly it was in great request, the thickened lump in the centre being cut out and preserved for use in cucumber frames, the windows of small cottages, etc. It is brought into the circular form by whirling round a piece of molten glass. Centrifugal force soon compels it to assume the form of a large flat thin disc. Sheet glass is rolled, as its name implies, and so also is plate glass. The thinnest crown glass that is made is $\frac{1}{16}$ in. thick, but the better qualities are thicker. Sheet glass is distinguished according to its weight to the foot superficial, 15 ozs. and 21 oz. being

the qualities most commonly used, although it is made as heavy as 42 ozs. to the square foot. The price varies according to size and quality, the qualities being distinguished as best, seconds, thirds, and fourths.

The glass that is most commonly kept and sold by oil and colour men and those who cut glass for the trade is Belgian sheet glass, and this the amateur will chiefly use. It is good enough for all ordinary purposes, and cheap. The amateur is recommended generally to have his glass cut for him instead of attempting to cut it himself, although if he be living at some distance perhaps from a town, it will be necessary for him to be able to cut his own glass.

When the glass is required in a small piece, comparatively speaking, for a window-pane, it is better to go to the oilman, or any glass-cutter to the trade; but if a quantity of glass be wanted for a greenhouse it will be found much cheaper to buy horticultural window-glass, which will be supplied ready cut to certain sizes, or in crates for the amateur to cut up himself. If the glass is cut to a certain gauge, the frames to receive it must be made to suit it with regard to length, and the width between the sash-bars; but if the glass is to be cut up, the frames may be made to suit the building.

It is desirable in any case that the amateur should possess the means of cutting glass, as it will often happen that through his want of skill in taking measurements, or through inattention of the glass-cutter to the measurements given to him, the glass will not fit. If it be too small there is nothing to be done but to get a larger piece; but if it be too large it can easily be reduced to the size required. It requires some little knack and practice to use a glazier's diamond. The angle will differ slightly for every diamond used for this purpose and the inclination to the glass at which the diamond will best do its work must be ascertained by actual trial. Thus it is that while one man can cut glass readily with a particular diamond, another can do little or nothing with it.

Appliances for Cutting Glass.—The amateur will not cut pieces of glass of any great size, and therefore a board measuring 3 ft. by 2 ft., or 2 ft. 6 in. square, or even 2 ft. square, will be large enough for a cutting-board. This board should be clamped at the ends, and its surface should be perfectly true and level. It will be of great assistance to the amateur if he carefully graduates this board along two of its adjacent edges, or even if he divides the area

into squares, the lines which represent the inches being thicker than those which denote half-inches, quarter-inches, etc.

If this be done there is no occasion to have the straight-edge of the T-square used as a guide for the diamond graduated. Thus, supposing that two of the adjacent edges of a piece of glass are true, or have been cut true, and it is required to cut a smaller pane 4 in. by 3 in. from a broken piece, for example, lay the glass on the board so that the true and square edges coincide with two adjacent edges of the board, and then putting the T-square over the glass 3 in. from one side, run the diamond over the glass and break away the piece thus cut, and next lay the T-square on the glass 4 in. from the other side, and with the diamond make another scratch, so as to take off the other piece that is over and above the quantity required. If the board is not graduated, the edges of the blade of the T-square must be divided into inches, etc. The T-square itself will need no description further than saying that the cross-piece which is brought against the edge of the board should be 1 ft. long, and the blade that lies on the glass from 2 ft. to 3 ft. (Pl. XXXII, Figs. 1 and 2).

The best kind of tool for cutting glass is undoubtedly the glazier's diamond, which consists of a handle about 6 in. long, flattened on two sides that it may be more easily grasped with the thumb and fingers, and fitted at the lower end into a piece of steel of rectangular shape, and bevelled at the bottom. The diamond projects from this bevelled end and the face of the bevel should be held parallel to the surface of the glass. The cutting edge of the diamond makes a clean cut or scratch from side to side, and by applying a gentle pressure the parts thus divided will come apart with a slight snap.

American Glass-cutter.—Fortunately, however, for those who could not or would not feel disposed to pay the price of a glazier's diamond, a cheap and efficient tool for cutting glass is to be found in the steel wheel glass-cutter. It consists of an iron handle, shaped so that it may be firmly grasped with the fingers and thumb, and bevelled at the lower end. This end is slotted to receive a small steel wheel of extreme hardness, the circumference of which projects for a short distance beyond the surface of the bevel. When this wheel is drawn over a piece of glass, a considerable degree of pressure being applied, the circumference cuts the glass, which may be broken apart along the scratch thus made. Owing to inability to keep the same pressure on the instrument throughout its course along the glass, the

Plate XXXI—PAPERHANGING

(1) Trimming the paper; (2) Pasting; (3) Folding, (4) Hanging the first piece; (5) Smoothing down

Plate XXXII—GLAZING

(1) Squaring and measuring; (2) Using diamond (3) Circular cutting

scratch made by the wheel of the cutter is not always complete, and the glass will break irregularly.

On the side of the glass-cutter there are notches of different widths. These are to enable the operator to break off any projecting pieces of glass that yet remain beyond the crack. This is easily done, and usually without injuring the piece wanted for glazing. Sometimes, through an accident, the pieces will be broken; and so, although the glass-cutter can be recommended for reducing pieces of glass that are a little too large or for cutting glass at odd times to repair breakages, it is for this very reason and to avoid waste that the amateur is advised when he has a heavy job of glazing in hand to get his glass cut for him, or to buy it ready for use from some wholesale dealer in glass for horticultural and other purposes.

The Putty Knife.—A putty-knife will be required, as without this it is impossible to finish the puttying by which a pane of glass is secured in its place, and bring the putty to an accurate and even bevel, slanting from the surface of the glass to the outer surface of the frame, so as to throw off the water that falls on the glass.

Knife for Hacking out.—For cleaning out the remains of a broken pane and the putty by which it is held, and which has grown extremely hard by age and exposure, a knife, technically called a hacking-knife, must be used. It has received this name because the removal of old glass and putty from a sash-frame is termed "hacking out." The knife itself is a stiff, wedge-shaped blade, broad at the back and bevelled away to a sharp edge, inserted between two pieces of stiff leather which serve as a handle, and which prevent the blows given to the knife by the hammer from jarring the hand. Some amateurs try to do this kind of work with their putty knife or with a chisel, much to the detriment of either.

Replacing a Broken Pane of Glass.—When replacing a broken pane of glass, first, the broken glass and putty must be removed with the hacking-knife, leaving clear the rebate into which the glass has to be fitted. If the injury done to the glass be but small, an effort should be made to preserve the largest fragment intact by cutting round it with a diamond and glass-cutter and pushing it out, holding a lump of putty against it that it may not fall and be broken. Sometimes it may be taken out whole without cutting round it, but cases in which this is done are very rare.

The rebate having been cleared, next measure the length and breadth of the opening *inside* the rebate.

Supposing, for example, that the exact measurement of the opening to be glazed is 18 in. by 12 in., an allowance should be made for fitting and the glass should be cut $\frac{1}{8}$ in. less each way, that is to say, $17\frac{7}{8}$ in. by $11\frac{7}{8}$ in. The glass is thus $\frac{1}{16}$ in. less every way than the opening that is to receive it and an easy fit is ensured. The measurement may be taken by marking the length and breadth of the opening accurately on a lath; tell the glass-cutter that this is the exact size of the space to be filled; he will then take care to cut the glass a trifle less in length and breadth that it may slip easily into its place. String should not be used for the purpose of measurement as it is liable to stretch.

Bedding of Putty for Glass.—The glass having been procured ready cut to size, or cut by the amateur if he possesses the appliances for doing the work, a bedding of putty must be carefully laid round that part of the rebate against which the glass is to be placed. The pane is then pressed in firmly against it, the necessary pressure being given by rubbing the thumbs along the edge of the glass. The bedding to receive the glass should be put all round the rebate, and the putty should not be spared, for if there be not sufficient there is a chance that the pane of glass may be cracked. When the glass is firmly fixed in its place putty must be applied all round the edge of the pane outside and shaped to a bevel by the aid of the putty-knife. The surplus putty that has been forced out on the inside of the pane by the pressure used in putting the glass in its place must also be removed.

Putty used in glazing is made of whiting mixed with as much raw linseed oil as is necessary to form it into a stiff dough. As, however, putty is extremely cheap, it is advisable to buy it ready made rather than to attempt to make it. When putty has been allowed to get hard it may be restored to its former condition by heating it and working it up again while hot. This is the reason why a piece of hardened putty grows plastic when held and worked up with the hot hand. For iron frames, or in any position where the rebate is of small size and but little putty can be used to fix in the glass, some white lead may be mixed with the putty, or putty may be made of white lead and litharge specially for the purpose. To avoid the bad effect of white putty near to putty that has been painted, when mending a broken window for example, some colouring matter

may be worked up with the putty to assimilate its colour as closely as possible to the colour of the painted part. Soft and new putty should always be used for bedding glass, because it is yielding and plastic, and will give way to the pressure brought to bear on the glass to bring it into its place.

The best way to preserve ordinary putty from cracking is to paint it as soon as possible after it is put on; and when putty has dried and cracked to such an extent that it allows the wet to enter, it is best to remove it and substitute fresh putty, or to run a brush charged with priming over it, working the bristles well into the cracks, and then to rub soft putty into the cracks to fill them up, after which the work should receive at least two coats of paint.

An excellent way to soften old putty is to take 1 lb. of American pearlash and 3 lb. of quick-stone lime, slake the lime in water, then add the pearlash and make the whole about the consistence of paint. Apply it to both sides of the glass, and let it remain for twelve hours, when the putty will be so softened that the glass may be taken out of the frame with the greatest facility.

Hard putty may also be softened by drawing a red-hot iron along it, and this mode of taking glass and putty out of old frames and garden-lights will be found useful when it is necessary to proceed to re-glazing. Care, however, must be taken when using the red-hot iron not to injure the wood-work. A frilling-iron used by laundresses will be found to be just the thing for this purpose.

Treatment of Wood-work before Glazing.—Before glazing a new frame or any new wood-work, the frame or sash, or whatever it may be, must be primed or painted with the first coat of paint. Putty will adhere readily to either glass or paint, and harden; but for wood in its natural state, or for stone, putty has but very little affinity, and for this reason it is necessary to paint wood-work before any glazing is done.

To clean Glass.—To clean glass, a little soap and lukewarm water may be used and when the surface of the glass begins to dry it may be polished with chamois leather. When glass is very dirty, it is useful to dissolve a little ammonia in water, and apply the solution thus made to the glass with a piece of rag; the ammonia in the water takes hold of and removes every particle of dirt, leaving the glass, after it has been polished, clear and translucent.

Darkening and Frosting Glass.—It is sometimes necessary to

darken glass, or to produce an imitation frosting on the surface, to render it semi-transparent, or so that while light can pass through it is not possible to see through it. For temporary purposes, a solution of Epsom salts, brushed over the glass, will immediately crystallize, the decorative crystals forming all over the surface; but when anything more durable is required, a little oil-paint should be used. In this kind of work a painter's brush should be used—one that is well worn is better—and a little colour being taken up on the ends of the bristles, it should be dabbed all over the inside surface of the glass, in a manner resembling "stippling." On glass treated in this way a pattern may be traced with the blunt end of a thin stick, giving the appearance of a clear pattern on ground or frosted glass.

Preparations for painting the insides of greenhouses, etc., may now be procured of most nurserymen and seedsmen, or of oil and colour men, at a cost not greatly exceeding that of paint.

General Memoranda on Glazing.—It now only remains to give a few memoranda with regard to glazing that will be useful to the amateur, but which cannot conveniently be classed under any of the sections in which the entire subject has been divided and grouped for greater facility of treatment. First, with regard to the mode adopted for cutting circular panes. The centre of the circle to be cut having been ascertained by measurement, a small plate or flat piece of wood is placed over it, covered with wax, putty or some other substance that will cause it to adhere to the glass on the lower surface, and having a hole sunk in the centre in the upper surface. An arm, having a pivot to work in the hole sunk in the plate, and carrying a socket which holds the diamond, and by which the diamond can be removed to any desired distance from the centre, is then placed over the glass, and the pivot is held with one hand firmly in the hole sunk in the plate while the diamond is carried round in a circle with the other hand, cutting the glass as it goes. For cutting a single piece of glass in this way an improvised substitute such as shown in Pl. XXX, Fig. 3 may be used.

Pieces of glass bought ready cut will be found to have the edge left by the diamond rather rough. For window-panes this is of no consequence whatever; but when it is necessary that the edges should be straight and smooth, and the corners taken off, this can be done by rubbing them on a flat piece of stone, with a little sand and water or emery and water. When it is necessary to frost one side of a pane or piece of glass—this can be

done by rubbing the surface required to be frosted upon a flat stone with emery and water. When two pieces are wanted their surfaces can be frosted by rubbing them one against another, with emery powder and water between.

For making holes through glass a common steel drill, of the size of the hole required, should be ground to a rather sharp point. The drill must be placed on the glass at the spot to be pierced, and caused to revolve rapidly, preferably by using an Archimedean drill stock. The sheet of glass must be bedded on putty, which greatly contributes to the success of the operation, because, although sufficiently unyielding to keep the glass up to the drill, it has a certain amount of elasticity. A more rigid material will not be found to answer. The drill should be kept lubricated with turpentine. It is of course easier to drill a small hole in glass than a large one, but with care and proper attention to the bedding, even large ones may be successfully bored.

A piece of glass tubing can be cut without difficulty by means of a common saw file.

Patent Glazing.—Before leaving the subject of glazing, attention may be called to the patent metal sash bars introduced in recent years and now very generally adopted in the construction of large greenhouses. There are several excellent systems. The amateur who may desire to choose between them may obtain full particulars of them on application to the various firms advertising in journals devoted to the interests of the building trade. The principle, however, is much the same in all cases; the glass is secured by a system of clips to strong metal bars, which may be of steel, zinc or lead. These are constructed so as to be perfectly water-tight. No putty or other cement is used and no external painting is required; squares of glass can be quickly replaced, and generally there is a considerable saving in the maintenance and repairs. It is claimed that by this system, glass can be put on in one-fourth the time required by the ordinary method.

INDEX

X

To face end matter]

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Leamington and District.
Littlehampton, Arundel, etc.
Liverpool, Birkenhead, etc.
Llandrindod Wells and Central Wales.
Llandudno and North Wales.
Llangollen, Corwen, Bala, etc.
London and Environs.
Looe and South **Cornwall.**
Lowestoft and District.
Lyme Regis and District.
Lynton and **Lynmouth.**
Malvern and District.
Margate, Westgate, etc.
Matlock and District.
Minehead, Exmoor, etc.
Newquay and North Cornwall.
Nottingham and District.
Paignton and South Devon.
Penmaenmawr, Llanfairfechan, etc.
Penzance and West Cornwall.
Plymouth and South-West Devon.
Pwllheli and Cardigan Bay.
Ramsgate and North-East Kent.
Rhyl and North Wales.
Ripon, Harrogate, and District.
St. Ives and West Cornwall.
Scarborough and District.
Seaford, Newhaven, etc.
Seaton, Lyme Regis, etc.
Sheringham, Runton, etc.
Sherwood Forest, Nottingham, etc.
Sidmouth and South-East Devon.
Southwold and District.
Stratford-upon-Avon.
Swanage, Corfe, etc.
Teignmouth and South-East Devon.
Tenby and South Wales.
Thames, The.
Torquay and District.
Towyn, Aberdovey, etc.
Wales, North (Northern Section).
Wales, North (Southern Section).
Wales, South.
Warwick, Kenilworth, etc.
Weston-super-Mare and District.
Weymouth and District.
Whitby, Robin Hood's Bay, etc.
Worcester and District.
Worthing and South-West Sussex.
Wye Valley.
Yarmouth and District.

SCOTLAND.

Aberdeen, Deeside, etc.
Edinburgh and District.
Glasgow and **the Clyde.**
Highlands, The.
Inverness and Northern Highlands.
Oban and the Western Highlands.

IRELAND.

Antrim (County), Portrush, Giant's Causeway, etc.
Belfast, Mourne Mountains, etc.
Cork, Glengariff, Bantry Bay, etc.
Donegal Highlands.
Dublin, Bray, Wicklow, etc.
Killarney and South-West Ireland.
Londonderry and County Donegal.

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